TECHNICAL REPORT NO. LWL-CR-03P73A

AN/TPS-61( ) HOSTILE WEAPON LOCATION TEST

by

J. L. Henry
Westinghouse Electric Corporation
Defense and Electronic Systems Division
Baltimore, Maryland 21203

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# U.S. ARMY LAND WARFARE LABORATORY

Aberdeen Proving Ground, Maryland 21005

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This report describes the modification of the AN/TPS-61 radar for hostile weapon location and the subsequent testing at Dahlgren, Virginia and Fort Sill, Oklahoma. The objective of the program was to determine hostile weapon location effectiveness, evaluation of mission data, and recommend system improvements. The radar system, test environment, test results, operational considerations, and recommended improvements are described. Performance against all three classes of field artillery (mortars, howitzers, CON'T

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20. ABSTRACT CON'T

and guns) was evaluated. In addition, the TPS-61( ) was evaluated as an
Air Surveillance Radar (ASR).

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# FOREWORD

The format of this final report is organized to adapt to the interest level of the reader. Each topic has been limited to two pages. The left hand page contains the essence of each subject in pictorial, graphical, or tabular format. In many instances, this material is self-explanatory. On the right hand page, the details are described in narrative form. This page should be consulted for the background, details, and additional comments. Those items which are not readily explained in two pages are contained in the annexes. A glossary of terms is included for the convenience of the reader.

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- Modify Basic TPS-61 for Hostile Weapon Location
- Familiarization with Projectile Detection at Dahlgren, Va.
- Determination of Weapon Location Capability at Fort Sill, Okla.
    1. Weapon Location in Clutter
    2. Determination of Weapon Class
    3. Weapon Location Using Resection Technique
    4. Observation of Air Burst Signature
    5. Effects of Radar Masking
    6. Effects of Single Piece vs Battery Firings
    7. Long Range Weapon Location.
- Mission Data Evaluation
- System Improvement Recommendations.

# AN/TPS-61 DEMONSTRATED ACHIEVEMENT
## (FORT SILL, OKLA. TESTS)

- Weapon Location at Ranges in excess of 25 km

- Weapon Located for 58 out of 73 Mission Sequences (80 percent)

| Mission Category | Number of Missions | Location Accuracy C.E.P. (Meters) |
|---|---|---|
| All Missions | 58 | 400 |
| All Unknowns | 29 | 360 |
| Unknowns (No Mortars) | 19 | 280 |
| All Missions (After 6 Feb.) | 18 | 220 |

- First or Second Round Cueing Capability on 75 percent of unknown mission (1 degree Azimuth Cueing Capability)

- One Radar Failure in 8 Weeks of Field Tests

- Tracked UH-IH Helicopter Out to 13 nmi at 25 ft Altitude (USAASO Test)

- Supported Missions in Foul Weather (Ice Storms, Rain, Snow, 50 Knot Peak Winds).

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A. In Operation at Fort Sill,Okla.
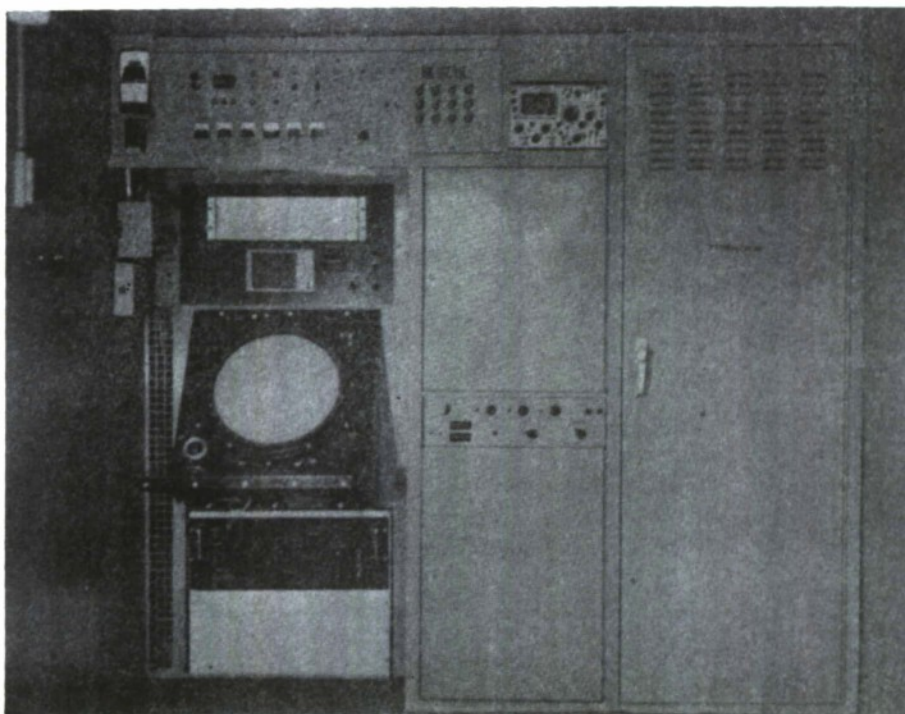


B. Interior View*

* 2/3 of S-280 Shelter Available for Operations Use

Figure 1. TPS-61

# FORT SILL TEST - LESSONS LEARNED

- Point clutter (towers, junked cars, mountains, etc) can capture pulse compression mode
- Projectiles observed behind optical mask
- Wide variations in projectile radar cross sections
- Raw radar data gave best estimate (computer not required)
- Point clutter attracts mortar engagements
- Experience improves location estimates
- Battery fire easier to locate than single weapon
- Five rounds sufficient for quoted accuracies
- Higher data rate and subclutter visibility (SCV) would be valuable.

# AN/TPS-61( ) SYSTEM DESIGN

- Frequency                 L-Band

- Range                    30 km (-20 DBSM Target)

- Coverage (2-D Radar)     360° (Azimuth)
  \>20 KFT (Altitude)

- Resolution             300 Meters (Range)
  2.7° (Azimuth)

- SCV                     50 dB

- Data Rate              4 Seconds per Scan
  25 Hits/Scan

- Minimum Range         $\approx$ 1.5 nmi

- Radial Velocity Coverage    >20 m/s

- Display Resolution       0.1 nmi (185 m) - Range
  0.1 degree (1.8 mils) - Azimuth

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# AN/TPS-61( ) HARDWARE DESCRIPTION

- **Antenna**
  - Integral Radar/IFF Feed
  - Doubly Curved Reflector ($CSC^2$) 18 feet wide.

- **Transmitter**
  - Final Stage - Cross Field Amplifier (100 kW peak, 2.5 kW average)
  - Totem Pole Driver - 5 Stage (5 kW peak, 125 W average)
  - Pulsewidth - 26 μsec Phase Coded.

- **Receiver**
  - Transistorized RF Amplifier (NF = 4.5 dB)
  - Digital MTI (4 Pulse Canceller, 10 Bits/Word)
  - Digital Pulse Compression (2 μsec Decoded)
  - Digital Video Integration (15/16 Feedback).

- **Display**
  - 16-inch PPI
  - B-Scope Storage Tube.

- **Shelter**
  - S-280 Shelter (2/3 Empty Space)
  - Antenna Stows in Shelter During Transit
  - Weight = 3,700 pounds (total system weight including shelter, radar and antenna).

- **Power Requirements**
  - 20 kW, 3φ, 400 Hz.

# MODIFICATIONS MADE TO BASIC AN/TPS-61

- New Equipment
  - B-Scope Storage Tube
  - AN/UPA-62 PPI Display
  - Video Mapper
  - Programmable Computer.
- Mechanical Changes
  - 15 rpm Antenna Scan (4 second data rate)
  - Antenna Searchlight Mode
  - Heat Exchanger.
- Mechanical Repackaging
  - Transmitter (Low Voltage Power Supply)
  - Receiver (RF Front End and Frequency Generator)
  - Display Area.
- Design Changes - Turn off Pulser Transformer.

# AN/TPS-61 MODIFICATIONS FOR WEAPON LOCATION

The AN/TPS-61 had been previously employed to provide medium-range low-altitude air surveillance of aircraft. The two basic parameters of high average power and clutter cancellation are the foundation for weapon location and air surveillance. The equipment modification consisted of new subsystems for weapon location and mechanical repackaging for improved operation (through interference reduction, more work space, and greater reliability).

A new display was installed for the weapon location task. This included a 16-inch PPI with decimal readout of range and azimuth. A 2:1 expansion of the sweep range permitted display of ranges consistent with detection of projectiles. A storage tube B-scope was provided, to accurately locate the origin of the hostile weapon trajectory. A video mapper was installed, to mark prominent features on the PPI. A programmable desk top computer allowed correction of raw data for earth's curvature, weapon-radar height differential, terrain masking, and nonsynchronous radar scan-weapon firing operation.

Previously, the radar had been operated at a 6 rpm scan rate. For weapon location purposes a higher scan rate of 15 rpm was provided. The radar was modified to provide a manual control of the antenna in azimuth (searchlight mode), and sector blanking of the transmitter as a function of azimuth was installed, for safety purposes. At Dahlgren, Va., the radar was operated near residential areas which were outside the regions of interest; consequently, the transmitter was turned off when the radar was pointing towards these areas. The heat exchanger was reconfigured to permit stowage in the shelter. Mechanical repackaging of the transmitter and receiver was undertaken to reduce internal interference between subsystems. For weapon location applications the radar operated continuously in the high average power mode; consequently, the turn-off pulser transformer was redesigned for a higher current rating.

# CALIBRATION AND MAINTENANCE PROCEDURES

- Antenna Azimuth Reference Calibration (30 Minutes):

  Purpose       Align PPI azimuth readings with Grid North as reference.

  Procedure

  1. Stabilize Radar System (Level Check)
  2. Locate Prominent Point Clutter (Tower)
  3. Attenuation of Receiver
  4. Manual Alignment of Synchro
  5. Verify Specific Point Clutter with Range Readout.

- Daily Preventive Maintenance (20 Minutes):

  Purpose       Determine system performance prior to mission.

  Procedure

  1. Receiver Alignment and MDS Checks
  2. Transmitter Waveform Checks
  3. Inspect water level in Heat Exchanger
  4. Verify Azimuth Reference
  5. Inspect Microwave Components for deposits
  6. Monitor Final Stage Output Current.

## ANTENNA ALIGNMENT AND DAILY PREVENTIVE MAINTENANCE

The antenna synchro alignment is presently an electrical procedure depen-
dent upon locating prominent point clutter such as water towers or TV towers.
This procedure is accomplished using the searchlighting mode, attenuating
the receiver front end until the designated point clutter is reduced to an MDS
paint on the PPI. The B-scope window is placed in the area, providing a
precise readout of the video. The clutter point is read to the nearest 0.1
degree, and the synchro is aligned to the known azimuth. A substantial re-
duction in implacement time would be realized by installing an optical bore-
sighting device. The optical/electrical axis would be aligned at the factory.
The tactical advantage is also obvious.

Daily maintenance procedures include receiver and transmitter set-up for
normal operation. The receiver alignment, MDS, and cancellation are
checked out with internally generated L-band test targets which allow the
receiver to be totally checked without turning on the transmitter.

The transmitter checkout is a two-stage process. It consists, first, of a
low-power Totem Pole Amplifier with associated meters and waveforms test
points for monitoring; the second stage consists of high power, CFA, radia-
tion monitoring of the CPA current waveform, and CFA detected RF output.
A single operator can set up both receiver and transmitter in about 15
minutes using the front panel meters and test points for go/no-go operation.

Weekly maintenance duties consist of water level and pressure checks of
the heat exchange unit, cleaning air conditioning filters, checking azimuth
reference, and antenna checkout for mechanical integrity.

The humidity (condensation on the equipment) experienced in the morning
was removed by operating the heater/air-conditioning unit.

# OPERATIONS AT FORT SILL

- Mobility
    - All equipment placed on 5-ton truck
    - 30 minute march order time
    - One hour implacement time
    - Assembled/disassembled 24 times
    - Transported weekly to/from test site.
- Logistical Support
    - 45 kW, 400 Hz Generator
    - 5 kW, 60 Hz Generator
    - Survey
    - Aiming Circle.
- Reliability
    - 196 hours of operation
    - 40 days at Fort Sill
    - One failure in 9 weeks
    - Supported all 17 tests.
- Operational Test Environment
    - 50 knot winds
    - Ice storm
    - Rain and snow
    - Mountainous terrain.

# OPERATIONS AT FORT SILL, OKLA.

The AN/TPS-61 was operated and maintained by a three-man crew during the 9 weeks of testing at Fort Sill. A 5 ton truck was used to transport the radar; a 2-1/2 ton truck (M35, M36), however, would have been sufficient. Aside from the movement between radar sites, the system was transported weekly to and from the base motor pool.

A 45 kW generator was used to supply prime power for the radar; the system, however, actually draws only 20 kW under a full load. A 60 cycle generator was used for test video recordsings and on-site computations, which are not necessary in a tactical situation. First order surveys of three radar sites were provided by Fort Sill; lower order surveys, however, would have been sufficient. The aiming circle was used to obtain azimuth masking angles and azimuth readings to calibration towers.

All missions during the 40-day test period were supported, with only one radar failure. This was an MOS memory failure, repaired by replacement with a spare plug-in module. The AN/TPS-61( ) operated in some severe weather environments. These included 50 knot peak winds and ice storms during the 105 mm howitzer location test (with site masking), and a snow storm with visibility of 1,000 meters during the 8-inch howitzer location test.

### Hours Logged at Fort Sill, Oklahoma

| Subsystem | Hours Logged |
| --- | --- |
| Receiver (Radar) | 196 |
| Totem Pole (Low Power) | 114 |
| CFA (High Power) | 102 |
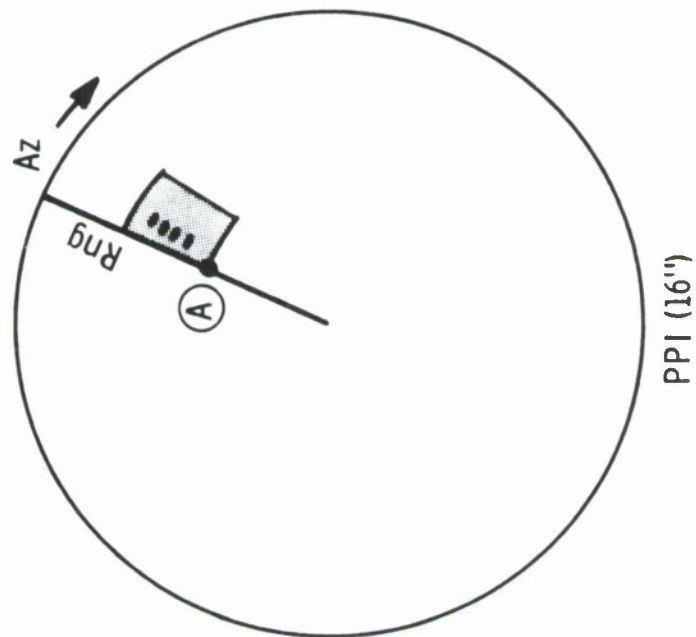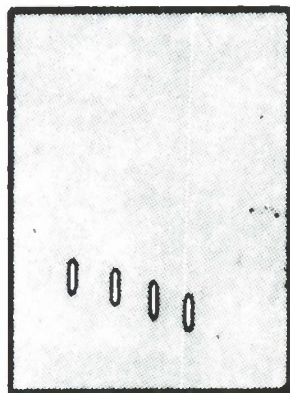
Figure 2. TPS-61 Display

# HOW WEAPON LOCATION IS DETERMINED BY
## AN/TPS-61( ) RADAR

The firing of a hostile weapon is first observed on the PPI display as successive scans. The operator places his cursor over the region of interest and ensures that the area to be expanded on the B-scope is adequate to cover the trajectory. The expansion area is clearly marked on the PPI. The dot A on the PPI and B-scope is presented in a decimal display to the nearest 0.1 degree and 0.1 nautical mile. The maximum expanded sector is 6 nmi in range and 20 degrees in azimuth and was employed exclusively during the Fort Sill tests. Two additional scales are available: 1.5 nmi by 5 degrees and 3 nmi by 10 degrees.

The operator then views the B-scope for the furthest scan back on the trajectory for successive rounds. After about five rounds, the furthest scan is marked. This represents the scan nearest the weapon firing. Several rounds should be observed, for maximum accuracy, to ensure that the radar scanned by the weapon as it was firing. There is no need to mark all scans, as the B-scope is a storage tube device, i.e., one with infinite persistence. The final radar estimate of range and azimuth is obtained by adding the decimal-displayed values and the graduated-scale values of the point marked. The B-scope can be erased or frozen, at operator option, by a pushbutton. Actual photos of weapons firing on the B-scope will be presented later.

# USE OF COMPUTER FOR WEAPON LOCATION ESTIMATE

- **Computer Corrections**
  - Nonsynchronous Firing and Radar Scan
  - Earth's Curvature
  - Radar-Weapon Height Differential
  - Radar Masking.
- **Test Data Indicates Use of Computer Questionable**
  - 55 percent of Sequences, Computer (without Mask Correction) gave worse answers than raw radar data
  - 83 percent of Sequences, Computer (with Mask Correction) gave worse answers than raw radar data.



$\phi_M$ - masking angle
QE - quadrant elevation
$H_M$ - height of mash at detection range
$H_C$ - height correction for earth's curvature
$H_R$ - height of radar

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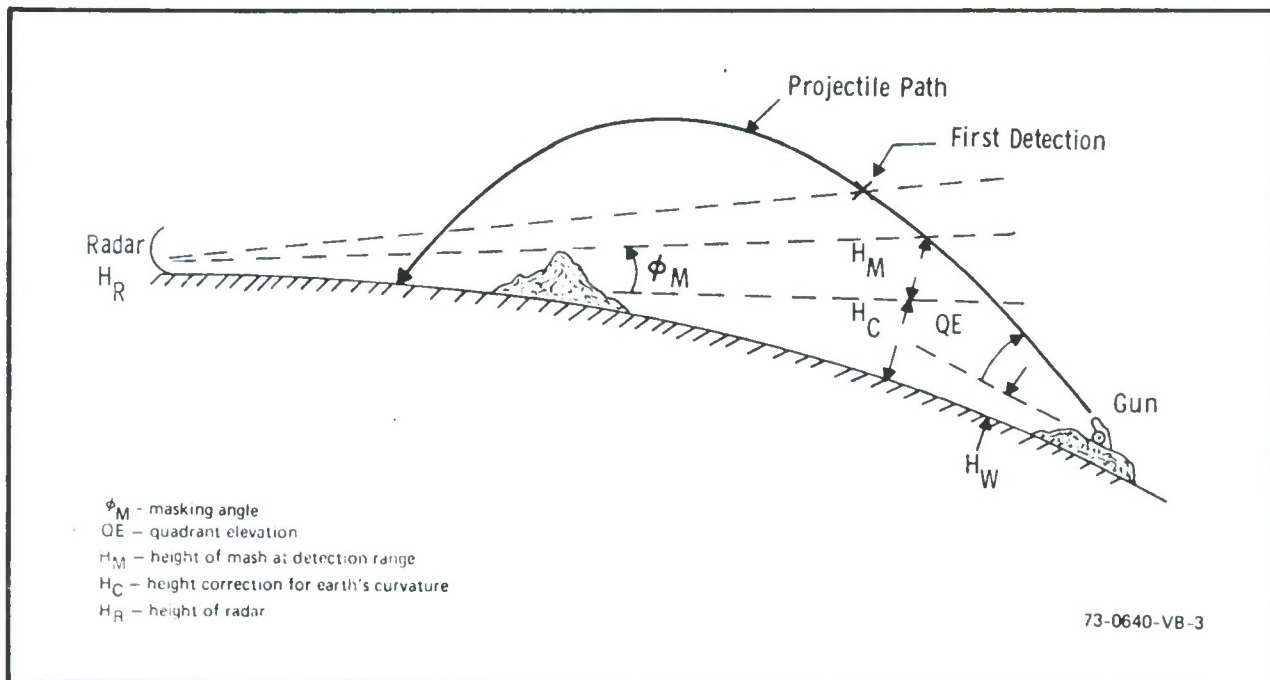
Figure 3. Physical Interpretation of Computer Corrections

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# COMPUTER CORRECTIONS TO RAW RADAR DATA

A programmable desktop computer was employed at Fort Sill to correct raw radar weapon coordinates. Four basic corrections were implemented. The radar scan and weapon firing are not synchronous operations. A probabilistic correction was made as a function of the number of rounds observed. The more rounds fired, the more likely that the radar scanned by as a weapon fired. Typically, five rounds were sufficient to remove this uncertainty. The earth's curvature and radar-weapon height differential corrections were also computed. These three corrections are described as location correction without masking. For those situations where the weapon is located below the visual terrain profile, an additional correction was performed. From an estimation of QE, described elsewhere, the location of the weapon is extrapolated back to account for the blind portion of the trajectory. Complete details of the procedure are described in Annex III. From the data reduced from the Fort Sill tests, it appears that the computer corrections gave worse location errors than the raw radar data. In the case of data correction, without masking, the average improved estimate was 182 meters and the average poorer estimate was 166 meters. The significant reason for poorer estimates with masking is the electromagnetic diffraction phenomenon and the variation of masking within a radar beamwidth. Many times the projectile was observed "out of the tube" even with an optical mask in the radar path.

## AN/TPS-61( ) VARIABLE OPERATING MODES

- Transmitter     - High and Low Power

- PRF     - High/Low and Fixed/Swept (Any Combination)

- Receiver     - MTI/Integrator/STC "On/Off" Independently
            - Normal/Test

- Antenna     - Scan/Searchlight

- Display     - Range Scale on PPI Continuously Variable
            Expanded Sector on B-Scope Selectable.

AN/TPS-61( ) OPERATING MODES

| Subsystem | Mode | Usage | Remarks |
|---|---|---|---|
| Transmitter | 1) High Power | Primary | 26 μsec Coded Pulse (Long Range Detection) |
| | 2) Low Power | Back-Up | 4 μsec Uncoded Pulse (36 percent Range Reduction) |
| | 3) Low Power | Back-Up | Final Power Amplifier "Off" (53 to 65 percent Range Reduction) |
| PRF | 1) High Swept | Primary | No Blind Speeds and Maximum Clutter Rejection |
| | 2) Low Swept | Back-Up | Used for very low Radial Velocity Targets in Low clutter areas |
| | 3) High Fixed | Verify | Used to verify suspected 2nd time around |
| | 4) Low Fixed | Verify | targets (momentary usage) |
| Receive | 1) MTI/Integ/STC | Primary | Employed in any Transmit/PRF Mode |
| | 2) Normal og VideoTest | Test | Used to determine MTI performance |
| | 3) RF Test Target | Test | Maintenance and troubleshooting applications |
| Antenna | 1) Scan | Primary | 15 rpm Standard (field change to 4, 6, or 12 rpm) |
| | 2) Searchlight | Secondary | Antenna controlled by Operator (CW or CCW) |
| Display | 1) 20 nmi PPI | Primary | 2:1 continuously variable expansion of each |
| | 2) 10, 5 nmi PPI | Secondary | range scale |
| | 3) 80, 160 nmi PPI | Air-Sur-veillance | |
| | 4) Centered Origin | Primary | Sweep origin relative to Radar |
| | 5) Off Centered Origin | Secondary | Target Range/Azimuth relative to some point other than radar (cuing mode) |
| | 6) B-Scan | Primary | Sector Selectable 1.5 nmi x 5 degrees<br>3 nmi x 20 degrees<br>6 nmi x 20 degrees |
| | 7) Video Map | Secondary | Displays Map on PPI to show tactical situation or prominent map features |

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## AN/TPS-61( ) NOT AFFECTED BY:

| Candidate Source | Rejected Because of |
|---|---|
| Birds | Frequency (L-Band), MTI |
| Insects | Frequency (L-Band), MTI |
| Rain, Snow | MTI, Frequency, CPACS |
| Distributed Clutter | MTI, CPACS |
| Other Radars | Phase Coded Transmission/Reception |
| Moderate Masking | L-Band Diffraction |
| Velocity Variations of Target | Variable Interpulse Period |
| Helicopters (Aircraft) | Distinguishable on PPI |
| ECCM* | Phase Coding, MTI, VIP |

*Only candidate interference source not tested.

## INTERFERENCE VS COUNTERMEASURES

| TPS-61 Design | Interference | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | Ground Clutter | Chaff | Birds/Insects | CW Jamming | Pulse Jamming | Pulse Repeater Jamming | Noise Jamming | Rain | |
| Frequency | X | | X | | | | | X | L-band permits diffraction over moderate masking |
| CPACS | X | X | X | X | X | | X | X | Most effective means of countering most jamming |
| Variable PRF | | | | | X | | | | Complicates the process of a jammer locking to PRF |
| RF STC | X | X | X | X | X | X | X | X | Effective over range of STC |
| Preselect Filtering | | | | X | X | | X | | Not effective against on-frequency jamming |
| MTI | X | X | X | | | | | X | Allows discrimination between fixed and moving targets on a radial velocity basis |

(1) CPACS decoder uses phase information. Random phase variations (rain, chaff, noise jamming, etc) are not correlated in the decoder and are rejected.

(2) Only birds observed was a migratory flight at Dahlgren. This detection was easily identified.

(3) Supported missions in rain, snow, and weather fronts at Fort Sill.

X denotes design effective against interference.

# Projectile Types*

81 MM Mortar
64–261 M/S

105 MM Howitzer
198 – 474 M/S

8" Howitzer
595 M/S (Max)

4.2" Mortar
108 – 256 M/S

155 MM Howitzer
213 – 561 M/S

175 MM Gun
914 M/S (Max)

4"

4"
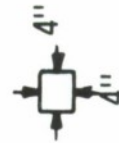
73-0640-VB-4

*To Scale

Figure 4.  Projectile Types

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# WEAPONS EMPLOYED FOR FORT SILL TEST

The AN/TPS-61( ) was tested for weapon location capability against every "tube" artillery type in the US Army inventory. As illustrated, there is a wide variation in target size and velocity, two important parameters in weapon location. For the purposes of these tests, the weapons were classified into three categories: mortars, howitzers, and guns. The trajectories of these three classes have their own distinguishing features. They can be constrasted in one or more of the following parameters: range, velocity, time of flight, maximum ordinate, and variability in possible quadrant elevations. Within each class are various types; e.g., within the howitzer class are the 105 mm, 155 mm, and 8-inch howitzer types.

## CAPABILITIES OF ARTILLERY WEAPONS

| Weapon | Maximum Range (Meters) | Elevation Limits (Mils) | Maximum Muzzle Velocity M/S |
|--------|------------------------|-------------------------|------------------------------|
| 4.2-inch Mortar | 5,650 | 800-1,065 | 293 |
| 105 mm Howitzer | 11,000 | 0-1,156 | 472 |
| 155 mm Howitzer | 14,600 | 0-1,333 | 564 |
| 8-inch Howitzer | 16,800 | 35-1,156 | 594 |
| 175 mm Gun | 32,700 | 35-1,156 | 914 |

B. MTI ON, 5-MILE RANGE RINGS, STC ON

POINT CLUTTER

D. JUNKED CARS AT 5 MILES RANGE AND 210 DEGREES AZIMUTH

MTI IMPROVEMENT

COMPARE

A. MTI OFF, 5-MILE RANGE RINGS

C. MTI OFF, 55 DB ATTENUATION IN RECEIVER
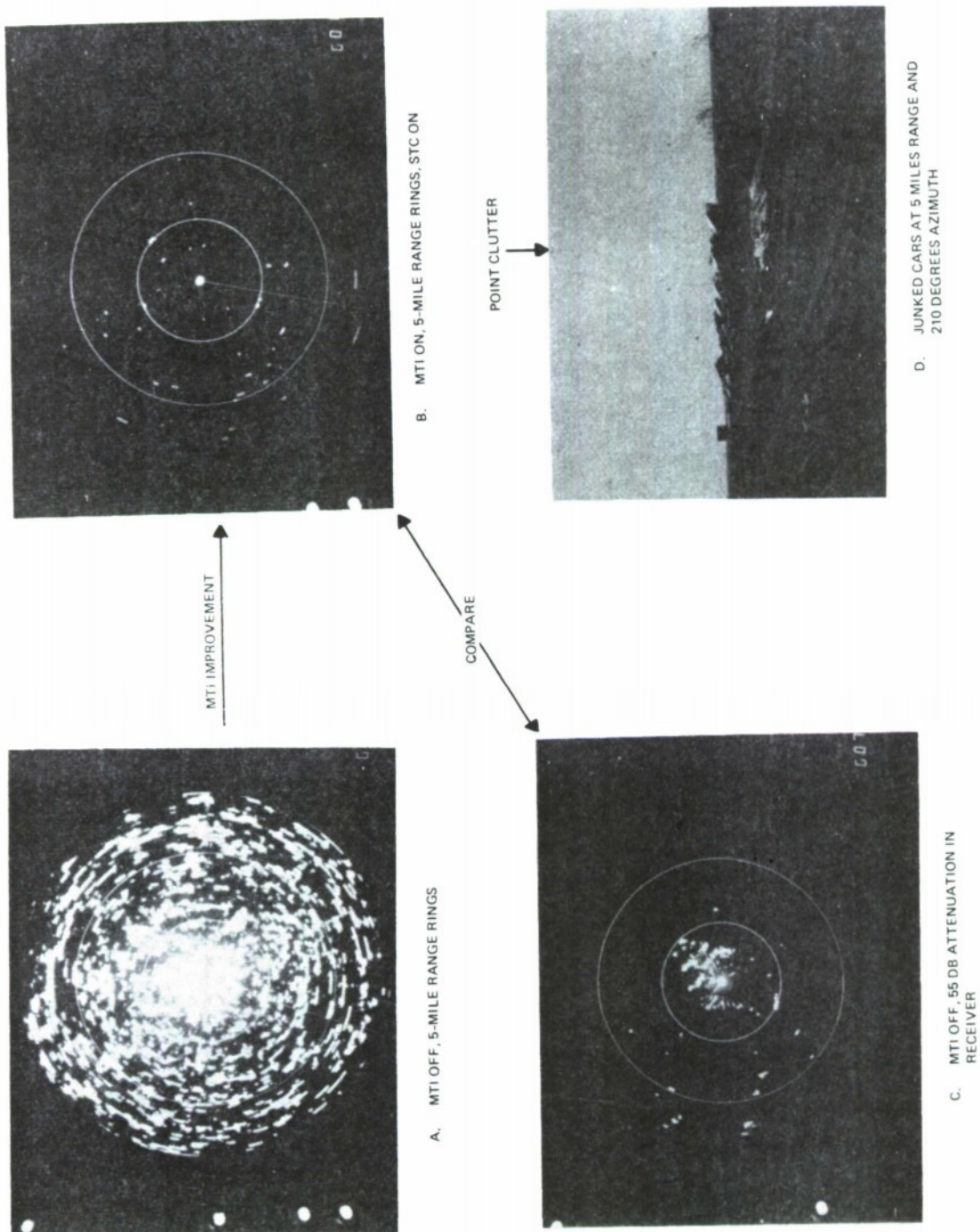
73-0640-BB-5

Figure 5. Fort Sill (Elgin Ridge) Ground Clutter Environment

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# AN/TPS-61( ) DEMONSTRATED CLUTTER REJECTION

The clutter photographs are representative of the ground clutter environment at Fort Sill, Oklahoma. Photograph a (figure 5) illustrates the ground clutter as seen by the AN/TPS-61( ) with the Moving Target Indicator (MTI) and STC turned "off." It is obvious that the clutter must be removed in order to locate targets. Photograph b demonstrates the utility of MTI. The remaining points consist of moving targets and point clutter. The point clutter in this photograph consists of large water towers, a power substation, TV tower, and mountains. It cannot be determined from this single scan photograph which points are targets and which are point clutter. In actual practice, the operator studies the PPI for each new radar location, and marks or remembers the stationary returns. The process takes about five minutes. Moving targets are characterized by successive movement of the paint from scan to scan. As a point of interest, the same radar located at Friendship Airport, Baltimore, Maryland presents a "black scope" except for the point clutter return from a large TV tower.

Some idea of the clutter rejection capability can be determined by attenuating the receiver with the MTI "off." Photograph c illustrates the reduction in clutter (and targets) with 55 dB attenuation placed in the receiver path. Note the similarity in point clutter in photographs b and c. Photograph d is a stockpile of junk cars which can be observed on the 5-mile range ring just to the left of the cursor in photograph b. This particular piece of point clutter was not removed from the PPI until 70 dB of attenuation was placed in the receiver.
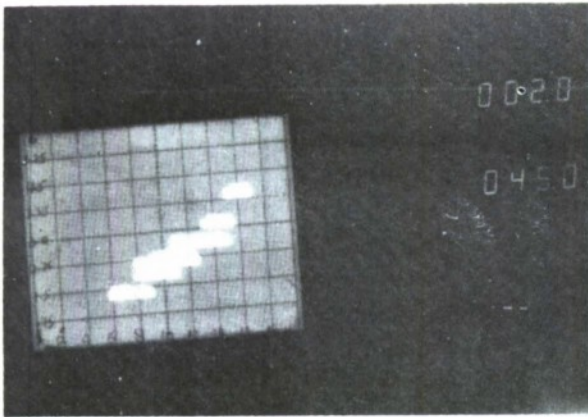
A. 105-MM HOWITZER
RANGE = 10 KM
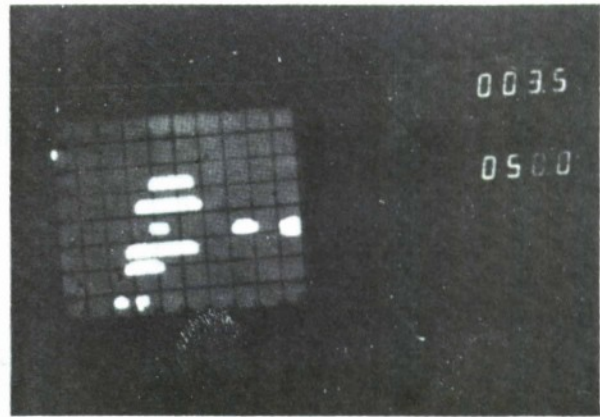
B. 8-IN. HOWITZER
RANGE = 13 KM
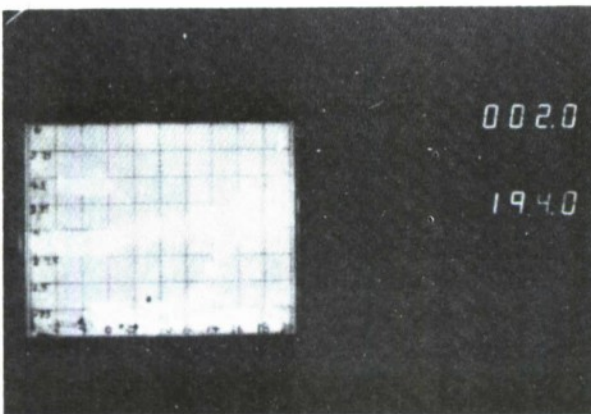
C. 105-MM HOWITZER AIR BURST
RANGE = 10 KM
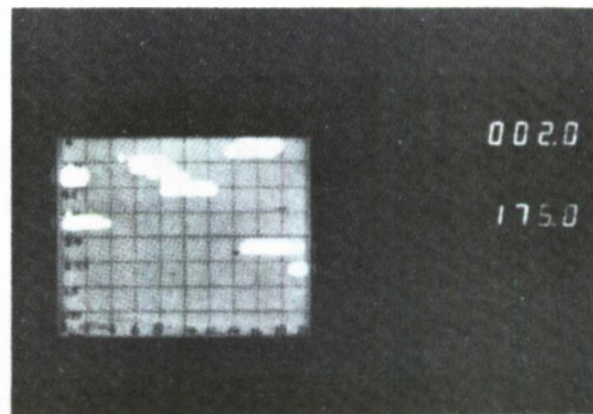
D. 4.2-IN. MORTAR (TOP CENTER)
RANGE = 14 KM

Figure 6.  B-Scope Presentation of Various Single Piece Weapons

# B-SCOPE PRESENTATION OF VARIOUS SINGLE PIECE WEAPONS

- View 1
  - 105 mm Howitzer
  - Test 10, Series 1, Round 25
  - Time of flight = 24 seconds
  - No. of scans = 6
  - Location error = 200 meters.

- View 2
  - 8-inch Howitzer
  - Target of opportunity
  - 50 knot peak winds
  - Rain
  - Note wider separation between scans.

- View 3
  - 155 mm Howitzer Air Burst
  - Test 8, Round 9
  - Bald Ridge central clutter across center
  - Air Burst located at bottom of display
    Air Burst lasted for several scans
  - Location error = 100 meters.

- View 4
  - 4.2-inch Mortar
  - Test 3, Series 5, 2 Rounds
  - 2 successive rounds fired (top center)
  - Location error = 150 meters.
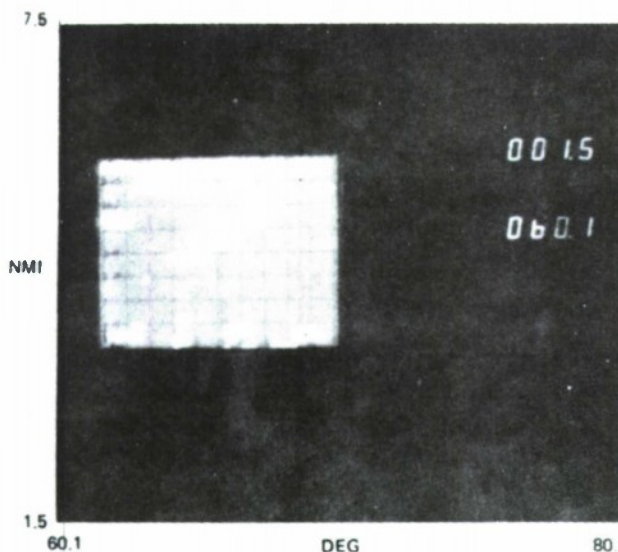
A. SINGLE PIECE REGISTRATION RANGE
(RADAR TO HOWITZER) = 12.5 KM
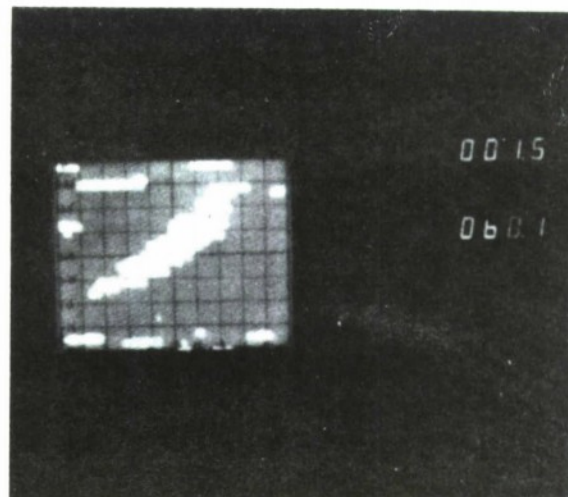
B. 155-MM BATTERY FIRE, 0 DB ATTEN
LOCATION ERROR = 380 METERS
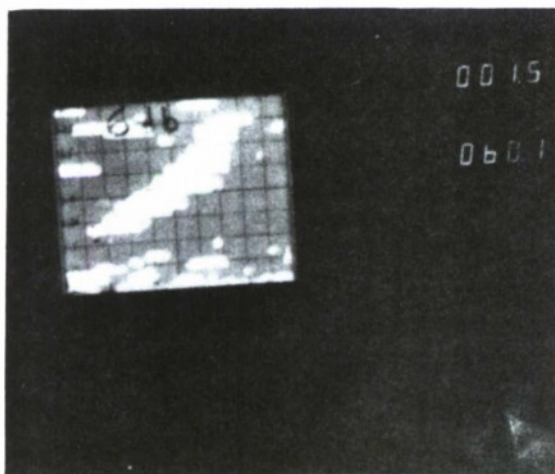
C. 155-MM BATTERY FIRE, 6 DB ATTEN.
(EFFECTIVE RADAR RANGE = 18 KM)
LOCATION ERROR = 80 METERS
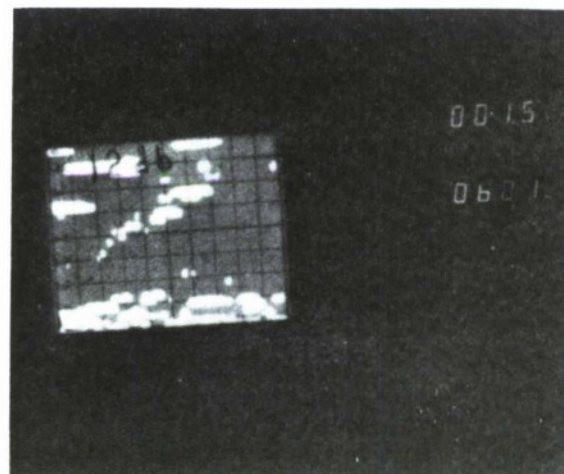
D. 155-MM BATTERY FIRE, 12 DB ATTEN.
(EFFECTIVE RADAR RANGE = 25 KM)
LOCATION ERROR = 360 METERS

- ATTENUATION IN RECEIVER INSERTED
  INTENTIONALLY

- ALL PHOTOS SCALED SAME AS A. ABOVE

- CLUTTER TO LEFT OF TRAJECTORY IS
  ORCT WITH TOWERS (POINT CLUTTER)

73-0640-BB-7

Figure 7. B-Scope Presentation of 155-mm Howitzer
Battery Location (Test 13, 2/27/73)

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# TYPICAL FORT SILL TEST AND ASSOCIATED SEQUENCES

- **Test Period Covered** - Feb. 27, 28 1973

- **Test Numbers 13, 13A**

  - #13    Weapon Location Known (2/27)

  - #13A   Weapon Location Unknown (2/28)

- **Weapon Tested** - 155-mm Howitzer (M109), Battery 4, 3 Transfers

- **Objective of Test** - Determine 155-mm Howitzer battery location capability. Previous tests were conducted with single piece. These tests were considered representative of a tactical fire mission.

- **Test Summary**

  - Radar Location = POA-2
    Weapon Location = Vicinity of QRCT Area

  - Rotary joint damaged when truck hit overhang while refueling on post. High VSWR areas sector blanked off range with no loss in test significance.

  - Radar could observe and locate battery fire at 12.5 km with intentional 12 dB attenuation in receiver (effective radar range = 25 km).

  - Heavy helicopter activity observed during mission.

  - Large piece of clutter observed at fire area - identified as QRCT hill with radio towers.

  - Registrations observed prior to mission #13.

  - Typical weapon location error for unknown sequences as 280 meters.
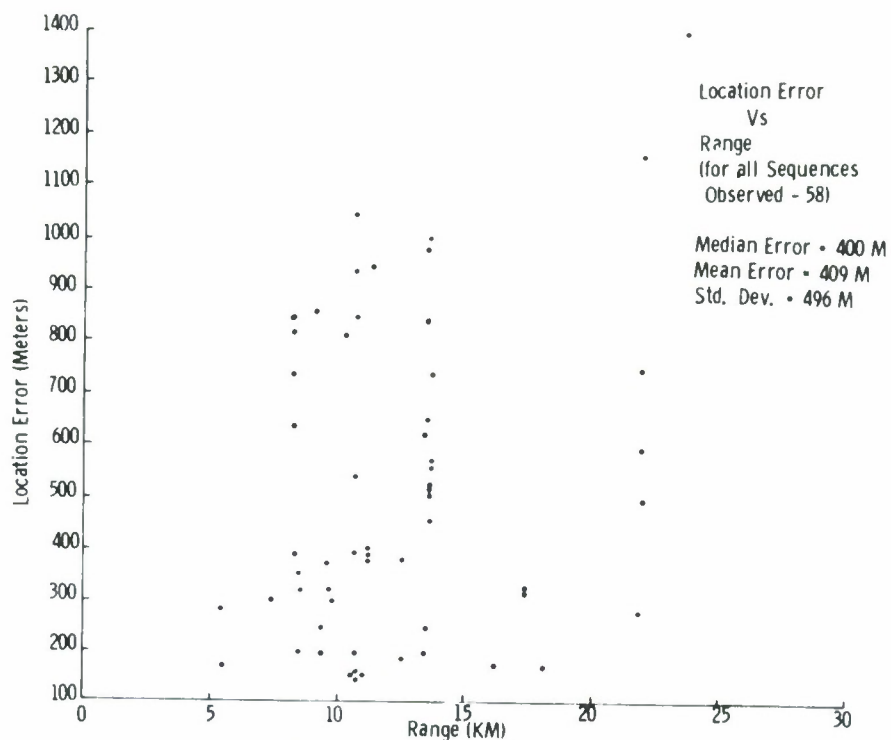
**A. Location Error Independent of Range**
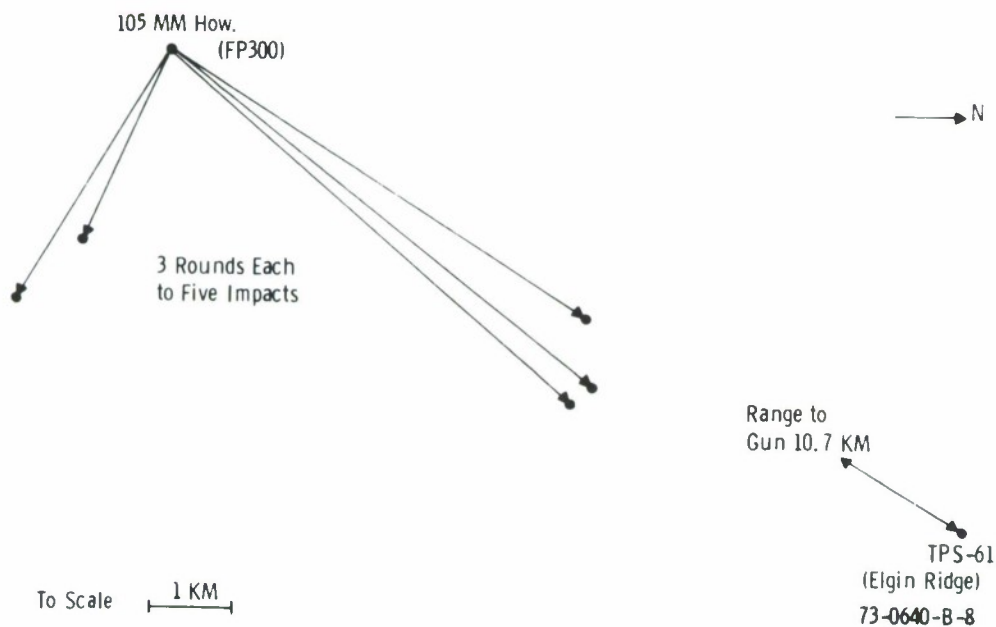
**B. Resection Error < 100 Meters for Multiple Engagements**

Figure 8.  Additional Test Results at Fort Sill

# DEMONSTRATED ADDITIONAL CAPABILITIES OF AN/TPS-61( )

- **Location Beyond Maximum Effective Range of Weapon**

| Weapon | Demonstrated Location* Range at Fort Sill (km) | Maximum Effective Range (km) of WPN |
|---|---|---|
| 81 mm Mortar | 5.4 | 4.5 |
| 4.2-inch Mortar | 22 | 5.6 |
| 105 mm Howitzer | 13.7 | 11.5 |
| 155 mm Howitzer | 27** | 14.6 |
| 8-inch Howitzer | 18.1 | 16.8 |

  *Does not imply maximum detection range
  **Target of opportunity

- **Classify Weapon Type**

| Sequence | WPN*** | Classed | No of Rounds Required | Derived Velocity M/S | Actual Velocity M/S |
|---|---|---|---|---|---|
| 1 | 155 mm Howitzer | Howitzer | 1 | 243 | 204 |
| 2 | 4.2-inch Mortar | Mortar | 1 | 130 | 136 |
| 3 | 105 mm Howitzer | Howitzer | 4**** | --- | --- |
| 4 | 175 mm Gun | Gun | 1 | .460 | 494 |

  ***Sequence and Weapon Not Known A Priori
  ****Transmitter "CROWBAR" at start of test

- **Location Error Independent of Range** - The major contribution to accuracy appears to be in point clutter obscuring part of the trajectory. Most of the points in the upper part of figure (1) were caused by this condition. The 1,400 meter error (worst location error) was due to the trajectory being over Signal Mountain.

- **Resection Capability** - Using resection techniques (figure 2) and the B-scope display during test 5, it was possible to locate the hostile weapon to within 100 meters. This was accomplished by recording the intersection of various trajectories during the five target engagement.

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# THE ELUSIVE 175 MM GUN

| Mission | Range to Gun (km) | Blip Scan Ratio %[1] |
|---|---|---|
| 4-4 | 13.7 | 90 |
| 15, 16 | 31 | 0 |
| 17 | 24 (Impact Range)[2] | 64 (last 1/2 of trajectory)[3] |

(1) Based upon time of flight and scan rate
(2) 175 mm fired away from radar
(3) High swept mode inoperative (blind speed problem)
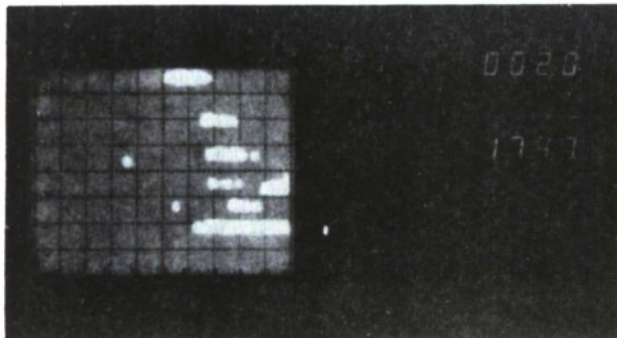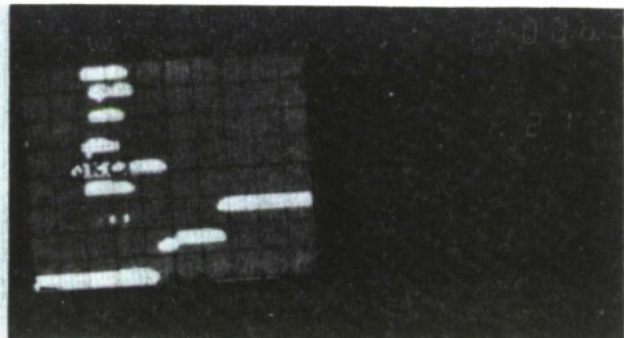


A  175-MM GUN, TEST 4-4          B  175-MM GUN, TEST 17          73-0640-BC-9

Figure 9.  B-Scope Presentations

# OBSERVATIONS OF 175 MM GUN FIRINGS AT FORT SILL

Three separate tests were conducted with the 175 mm gun. The only missions where no radar detections were observed, occurred during the long range weapon location tests (15, 16). In fact, forty rounds were fired over a two-day period with no radar detections except for impact. There was sufficient time between rounds to place the radar in various modes: antenna tilt variation, scan/searchlight, variable threshold settings (video integrator), final transmitter stage "on/off," and pulse compression "on/off." While no firings were observed for the 175 mm gun, a 155 mm howitzer at 27 km range was observed and located during the tests. This was later verified by consulting the Fort Sill daily firing schedule. The radar appeared to be operating normally; consequently, the only explanation seems to be one of radar cross section for this particular mission. For weapons of this class the radar cross section can vary as much as 50 dB depending upon aspect, pitch, and roll. Target radar cross sections of -50 DBSM ($1/100,000$ m$^2$) can be expected. The other 175 mm gun missions gave excellent radar detections.

## 175 MM GUN MISSION DATA

| Mission | MV (m/s) | QE (mils) | TOF (sec) | Radar Location |
|---------|----------|-----------|-----------|----------------|
| 4-4 | 511 | 266 | 31 | Elgin Ridge |
| 15, 16 | 914 | 541, 560 | 70, 72 | Post Oak Area |
| 17 | 704 | 680 | 67 | Gate House Area |



QE -541 MILS
TOF - 70 SEC
ALT (MAX) - 5900
MV - 914 M/SEC
TERM VEL - 338 M/SEC
ROUNDS - 10

73-0640-VA-10
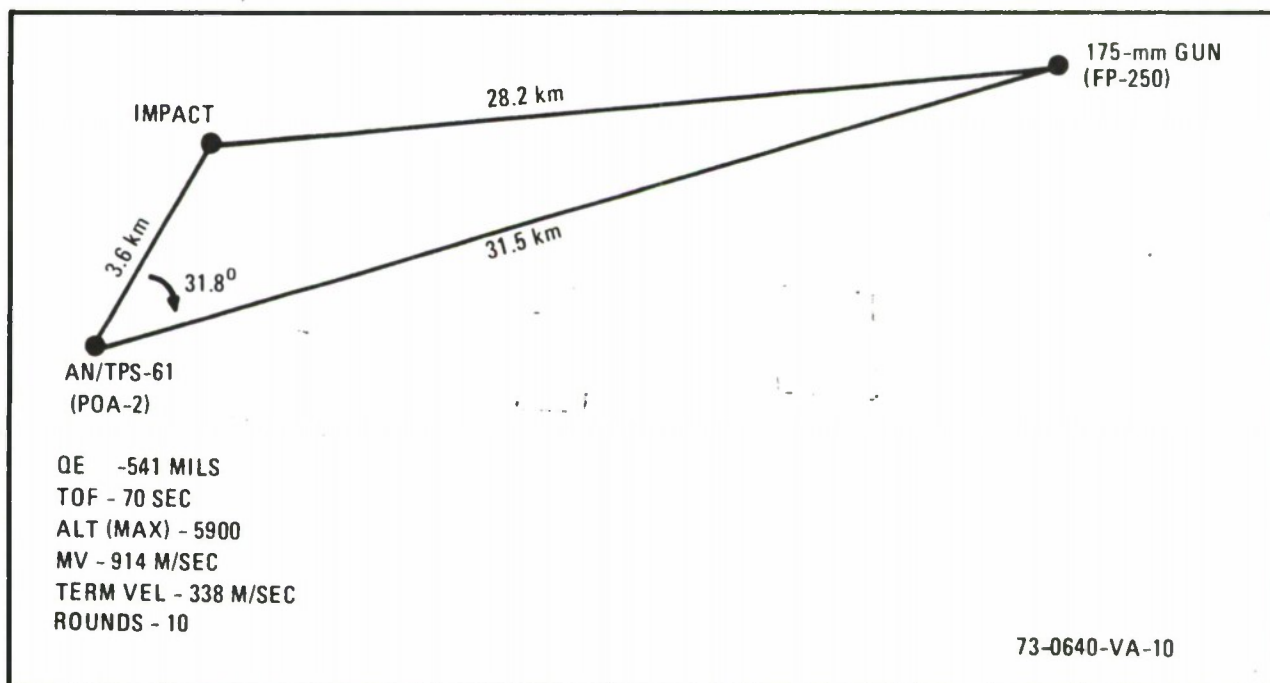
Figure 10. Geometry and Firing Data, Test 15

## AN/TPS-61( ) CAN ESTIMATE QE AND CHARGE

| Weapon | Actual QE (mils) | Chg | Operator Estimate* QE (mils) | Chg |
|---|---|---|---|---|
| 8-inch Howitzer | 671 | 7 | 590 | 7 |
| | 518 | 7 | 524 | 7 |
| 155 mm Howitzer Battery | 305 | 6 | 320 | 6 |
| | 349 | 6 | 370 | 6 |
| | 331 | 6 | 370 | 6 |
| 105 mm Howitzer | 566 | 4 | 300 | 4 |
| | 525 | 4 | 320 | 1 |
| | 449 | 4 | 320 | 1 |
| 105 mm Howitzer | 456 | 4 | 370 | 4 |
| | 536 | 4 | 290 | 4 |
| 105 mm Howitzer | 317 | 6 | 370 | 6 |
| | 357 | 5 | 340 | 5 |
| | 417 | 4 | 310 | 4 |
| | 276 | 3 | 360 | 2 |
| | 297 | 3 | 360 | 2 |
| | 264 | 2 | 330 | 1 |

*All Unknown Missions Except Mortars.
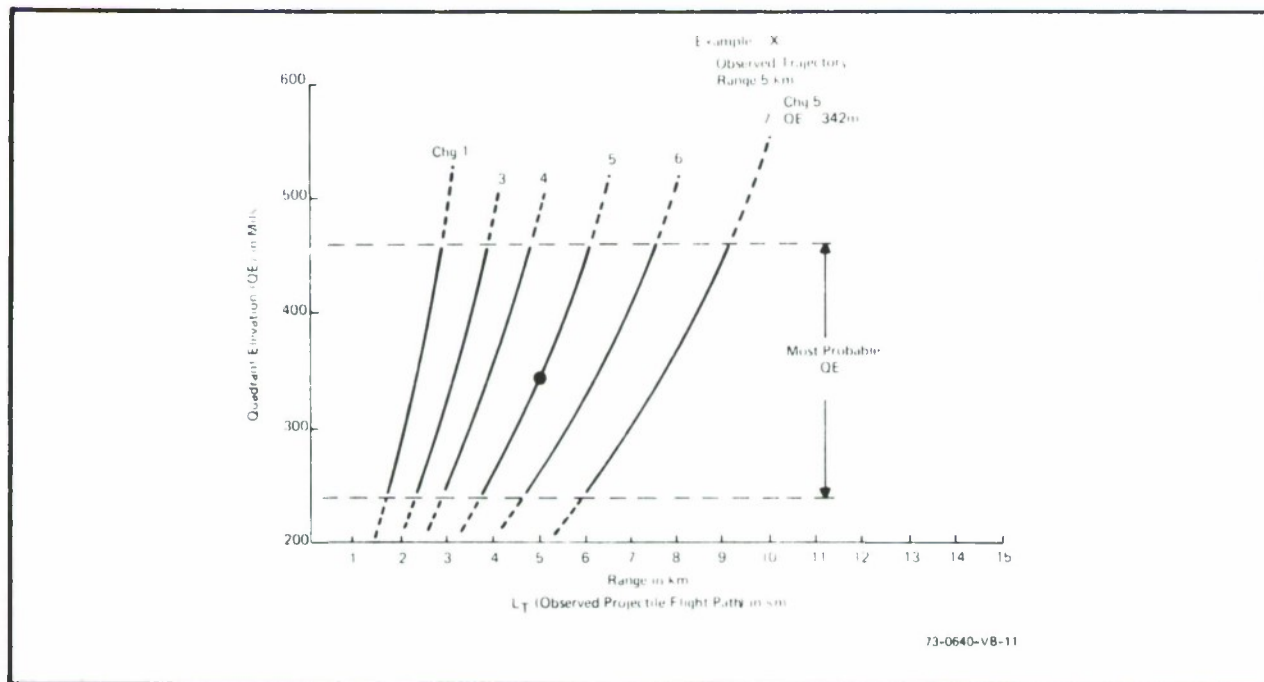


Figure 11. Estimation of QE and Charge

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# ESTIMATION OF QE AND CHARGE FROM RADAR OBSERVATIONS

As part of the computer corrections to raw radar data, it was required to estimate weapon QE and charge (muzzle velocity). This is accomplished by observing the gun trajectory ground range (weapon to impact range) on the B-scope. The observed projectile flight path length indicates a best or more probable weapon charge and QE. A series of graphs similar to the one shown were prepared for each weapon type. As an example, if the weapon range observed was 5 km, then the most probable charge was five and the QE was 342 mils. Of course, charge six and low QE or charge four and high QE could have been used. However, it is typical for howitzers to use QE's from 240 to 460 mils.

The table presents a comparison of the operator's estimate of QE and charge and the actual gun data. The data presented is for unknown missions with the exception of mortars. The reason mortars are not listed is that the 4.2-inch mortar was fired at 900 mils for all tests. Range variation for the 4.2 inch is accomplished by varying charge rather than QE. Of the 16 missions, 11 estimates of charge were in agreement. The two large discrepancies in charge (4 vs 1) was due to the radar not observing a large portion of the trajectory. Point clutter obscured part of the trajectory; consequently, a short gun range was assumed which resulted in a lower estimate of charge and QE.
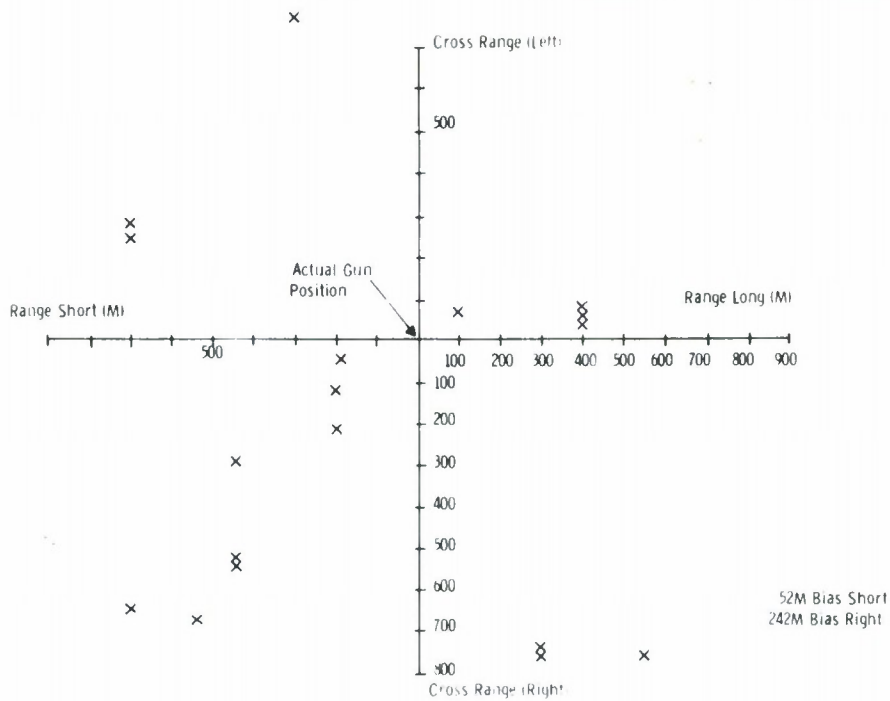
**A. Range and Cross-Range Errors, East Range**
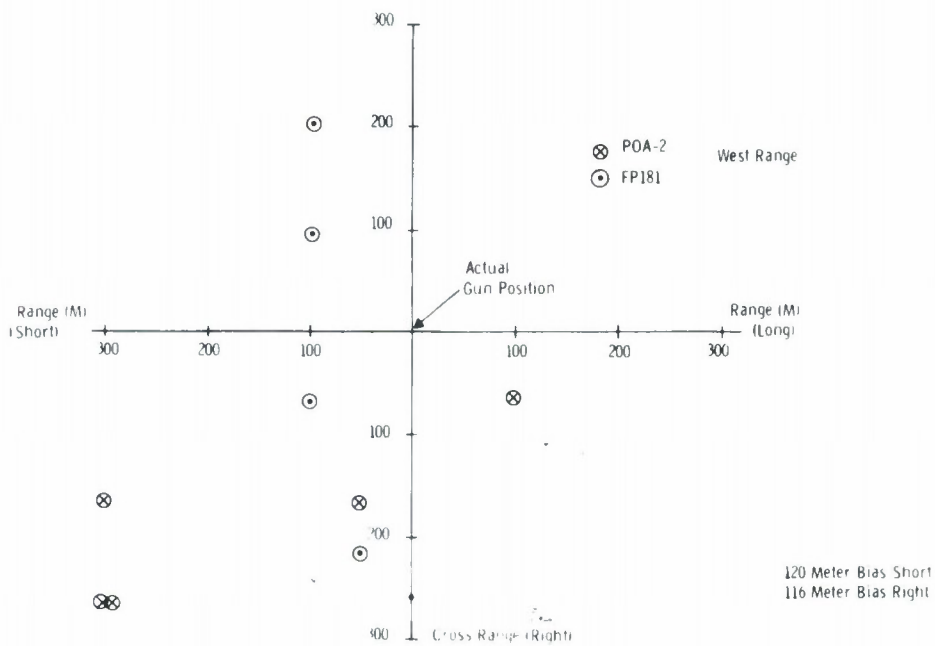
**B. Range and Cross-Range Errors, West Range**

73-0640-BC-12

Figure 12.   Range and Cross-Range Errors of
Unknown Sequences

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## BIAS ERRORS IN WEAPON LOCATION ESTIMATION

The location errors described in this report are the length of the line segment between the radar estimate and the actual weapon location. This analysis gives some insight into the range and cross-range components of the line segment. Figure 12 presents these errors for unknown sequences at three different radar sites. The range error is referenced to the radar-gun line and the cross-range error is a function of the azimuth estimate and radar-gun range. For the unknown sequences there appears to be a bias right and short.

The data used for this analysis was the raw radar data. Computer correction actually increased the errors in location estimation. The errors in the east range data are larger than the west range data primarily because of point clutter obscuring the initial part of the trajectory. More point clutter existed for the east range tests. While not shown in this data, the location error was found to be independent of range.

Much of the range bias could be removed by correcting only for non-synchronous radar scan (see Annex III). For the west range data, the average scan correction is 177 meters added to the raw radar data. The correction for the east range data would be smaller due to the preponderance of mortar missions which have higher QE and lower muzzle velocity. The azimuth bias would be reduced by optical calibration and shortening the variable interpulse period from 16 to 8 pulse repetition intervals. Both of these improvements are recommended in future designs.

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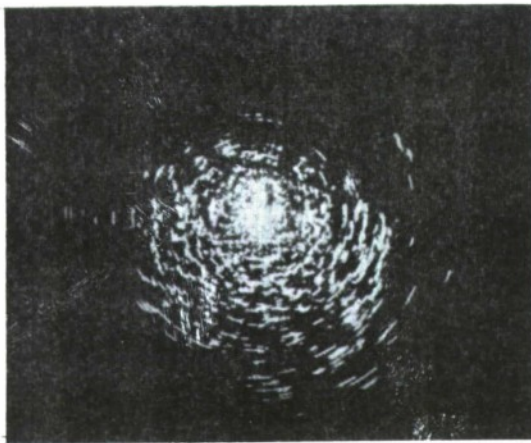
A. MTI OFF, 20 NMI RANGE (SINGLE SCAN)
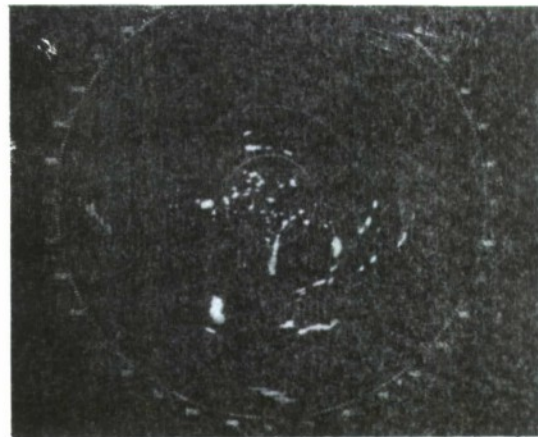
B. MTI ON, 20 NMI RANGE (20 SCANS, NOTE AIRCRAFT LANDING AT LAWTON AIRPORT)

FORT SILL
FP181
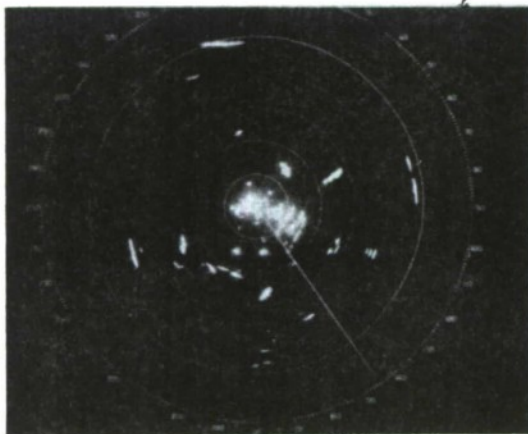
C. MTI ON, 60 NMI RANGE (20 SCANS)
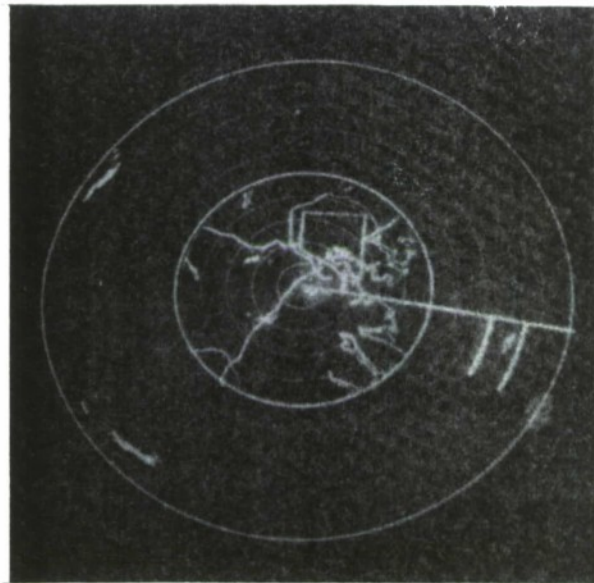
D. MTI ON, 50 NMI RANGE (MULTIPLE SCAN PHOTO WITH VIDEO MAPPER PRESENTATION, TAKEN AT FRIENOSHIP AIRPORT, BALTIMORE, MARYLAND. NOTE OUTLINE OF CHESAPEAKE BAY)

73-0640-B-13

Figure 13. PPI Presentation of AN/TPS-61( ) in ASR Mode

# AN/TPS-61( ) AIR SURVEILLANCE RADAR MODE

The AN/TPS-61( ) was also tested at Fort Sill for its ASR capability. To change from the weapon location mode to the ASR mode, it is only necessary to change the range scale on the PPI. The ASR mode can be used for surveillance of aircraft to assure the effectve use of airspace, vectoring aircraft to provide separation and radar navigation, and coordination of artillery supporting fires and aviation activities.

View (1) shows the radar clutter for a 20 mile radius, single scan, and MTI "off" at Fort Sill, Oklahoma. The lack of clutter returns to the north is due to the terrain masking of the Wichita Mountain range. View (2) is a display of the same area for 20 scans with the MTI "on." Most of the remaining points are from targets of opportunity. Note the approach of an aircraft (due south) into the Lawton Municipal Airport. View (3) is for 60 nautical mile (radius) coverage from the same location. View (4) is a multiple scan photo taken in the Baltimore, Maryland area. The outline of Baltimore and the Chesapeake Bay area is presented on the PPI with the aid of the OA-8554/G video mapper. Note that there is less clutter return in the Baltimore area than at Fort Sill, Oklahoma, which is to be expected. Aircraft have been observed at Fort Sill at ranges of 130 nautical miles.

## ASR Flight Test

Flight Test AN/TPS-61 ( )- Radial
Fort Sill, Oklahoma 16 Feb 1973
Aircraft UH-IH (80 Knots)

―――― Helicopter Route

------ Terrain Highest Elevation

0 - No Return
1 - Unusable Return
2 - Usable - No Trail
3 - Usable W/Trail
4 - Full Return

Radar

Differential Alt in Feet

Distance from AN/TPS-61( ) in Nautical Miles

73-0640-VB-14

* Test and Data Courtesy USAASO

Figure 14.  ASR Flight Test

# AN/TPS-61( ) ASR TESTS

Under the direction of the US Army Aeronautical Services Office (USAASO), the AN/TPS-61( ) was tested during the Fort Sill tests. The test was planned, coordinated, and conducted under their control. The purpose of the test was to determine the capability of the radar to detect low flying helicopters in a ground clutter environment.

For the purposes of the test, a UH-IH (Iroquois) helicopter was flown at 25 feet above local terrain at 80 knots in a radial path from the radar. The qualitative performance figures (denoted by zero to four entries) on each scan are the judgement of a qualified air traffic controller from USAASO. The trail mentioned in judgements 2 and 3 relate to the persistence of the PPI on the preceding scan. Additional tests dealing with tangential flights (with respect to the radar) are presented in the annexes. As illustrated, the target could be observed below optical line of sight, as was the case in weapon location. On numerous occasions, aircraft were observed at ranges in excess of 100 nautical miles without changing from the weapon location radar mode, except for PPI scale.

# DAHLGREN (NWL) TEST - SYSTEM FAMILIARIZATION

- Shakedown for Fort Sill Test
    - Refine operating procedures
    - Debug radar modifications
    - Train radar crew
    - Verify theoretical detection of projectiles
    - Systematize azimuth alignment procedures
    - Determine effectiveness of various radar modes.
- Environment
    - Projectile trajectory over water
    - Weapons fired exclusively from high point clutter area
    - Numerous point clutter returns (towers, bridges, and reflectors).
- Utility of Tests
    - Verified detection at ranges of 23 km (5 inch and 81 mm)
    - Improved reliability of radar prior to Fort Sill tests
    - Acquired appreciation for coordinated conduct of tests
    - Finalized reporting procedures of test results
    - Reduced number of surprises at Fort Sill.

# FAMILIARIZATION WITH PROJECTILE DETECTION TESTS

After the basic AN/TPS-61 was modified for a weapon location capability, a shakedown test was performed at the Naval Weapon Laboratory at Dahlgren, Virginia. The close proximity to the Westinghouse plant and numerous targets of opportunity made this location ideal for the test objective. Approximately four weeks were spent at Dahlgren prior to proceeding to the more formal test period at Fort Sill, Oklahoma.

It was recognized early that the environment was not typical (fixed firing point, operation over water, and numerous man-made clutter structures); however, the primary objectives were met. Equipment deficiencies were corrected and the radar crew was trained during this period. It was noted that weapons firing from large point clutter areas (exclusively the case at Dahlgren) had part of their trajectory obscured. This was reconfirmed during the Fort Sill tests (see figure 5). In order to get a weapon location estimate it was necessary to reduce the radar pulsewidth from 26 μsec to 4 μsec. This technique proved useful at Fort Sill in locating mortar firings near point clutter areas.

The tests against primarily targets of opportunity, indicated a need for additional training and practice prior to proceeding to Fort Sill. This was accomplished by using a programmed target simulator, realistic target display, and map exercises. Scenarios were generated for various classes of weapons (mortar, howitzer, and gun) using the Fort Sill maps with planned radar locations to obtain weapon location estimates. Improved reporting and documentation procedures also resulted from this useful exercise.

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# SIGNIFICANT PERFORMANCE IMPROVEMENT WITH NO IMPACT ON PRODUCTION COSTS

- Reduce Point Clutter Capture
- Double Data Rate of Scan
- Improve Mortar Location Capability
- Reduce Azimuth Smear
- Reduce Emplacement Time
- Improve Dynamic Range of Receiver
- Reduce Operator Reaction Time and Chance for Error
- Provision for Multiple Engagement Location.

# RECOMMENDED SYSTEM IMPROVEMENTS TO AN/TPS-61( )

| Improvement | Accomplished By |
|---|---|
| Reduction of point clutter capture and clutter effects | Reduce Barker code transmission and reception to 13 and 1 μsec respectively |
| Double data rate of scan | Increase scan rate to 30 rpm |
| Improve mortar location capability | Reduce alternate transmit mode to 1 μsec and remove first blind speed notch by variable weighting of coefficients |
| Reduce azimuth smear | Install top level limiter in digital integrator |
| Reduce emplacement time and eliminate need for surveyed towers | Provide optical scope for azimuth calibration |
| Improve dynamic range of receiver from 54 to 66 dB | Install 12 bit A/D converter in receiver |
| Reduce operator reaction time and change for error | Install B-scope cursor |
| Provision for multiple engagements | Install several addressable B-scopes |
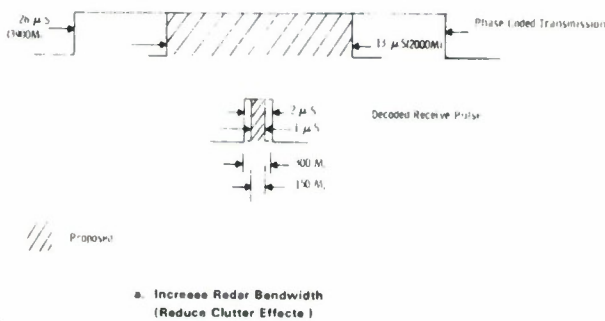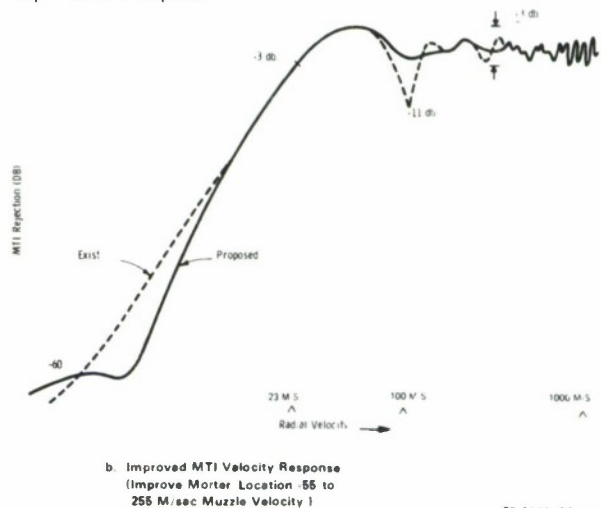
Figure 15. CPACS and MTI Improvement

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# GLOSSARY OF TERMS

| | |
|---|---|
| ASR | – Air Surveillance Radar |
| B-Scope | – Video display in range and azimuth coordinates (sector expansion of PPI) – rectangular coordinate system |
| Blip Scan Ratio | – Ratio of number of scans observed to possible number for a given time of flight |
| Btry | – A Battery for test purposes is six guns under one unit. |
| CEP | – Circular Error Probability – radius of the 50 percent probability circle |
| CFA | – Cross Field Amplifier (final transmitter stage) |
| Charge | – Amount of propellant used to vary muzzle velocity |
| Confirm | – Test where complete data supplied prior to mission |
| CPACS | – Coded Pulse Anti-Clutter System – Uses phase coded pulse (13 bit Barker Code – pulse compression) |
| $CSC^2$ | – Cosecant-squared antenna pattern where power radiated is proportional to $CSC^2\ \theta$, where $\theta$ is the elevation angle |
| CUE | – Functional capability for handing over target position to another sensor |
| DBSM | – dB relative to one square meter |
| Distributed Clutter | – Natural terrain excluding point clutter |
| FP | – Firing Point |
| Locate | – Test where no a-priori information given except weapon type, approximate time, and general area |
| Location Error | – Distance between TPS-61 estimate and actual weapon location (length of line segment) |
| Mask | – Natural terrain obstacle which is optically above local horizon |

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# GLOSSARY (Continued)

| | |
|---|---|
| MDS | – Minimum Detectable Signal |
| MIL | – 1/6400 of a circle (1 degree = 17.7 mils) |
| MTI | – Moving Target Indicator, a device to reject unwanted clutter |
| Point Clutter | – Large fixed obstacles - towers, bridges, mountains, etc |
| PPI | – Plan Position Indicator - polar coordinate display of range and azimuth |
| QE | – Quadrant Elevation (see FM 6-40, p. 2-11) |
| Searchlight | – Radar azimuth controlled by operator |
| Sequence | – Variation in test, usually one parameter changed. Parameter may be location, impact point, weapon type, etc |
| STC | – Sensitivity Time Control varies the sensitivity of the receiver as a function of radar range |
| Test | – Specific objective to determine capability |
| TIS | – Test Information Sheet, a concise description of test events and data |
| TOF | – Time of flight |
| WPN | – Abbreviation for weapon |

# RADAR SITE LOCATIONS AT FORT SILL, OKLA

N

⊗ Elgin
Ridge

⊗ POA-2

West Range

⊗ FP181

East
Range

⊗ Gate House

Scale —— 3 KM

73-0640-VB-16

Figure 16.  Radar Site Locations at Fort Sill
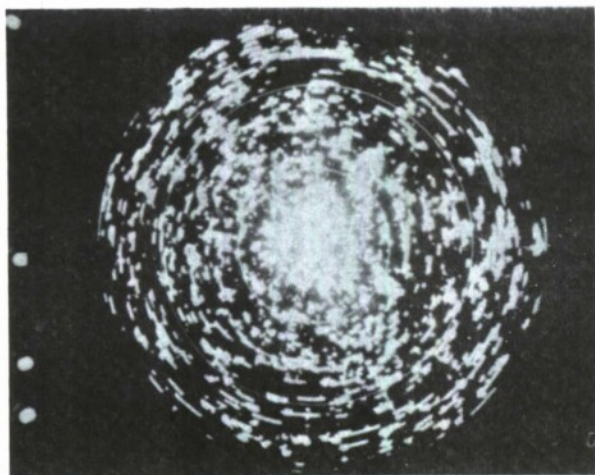
A.   MTI OFF, 0 DB ATTEN
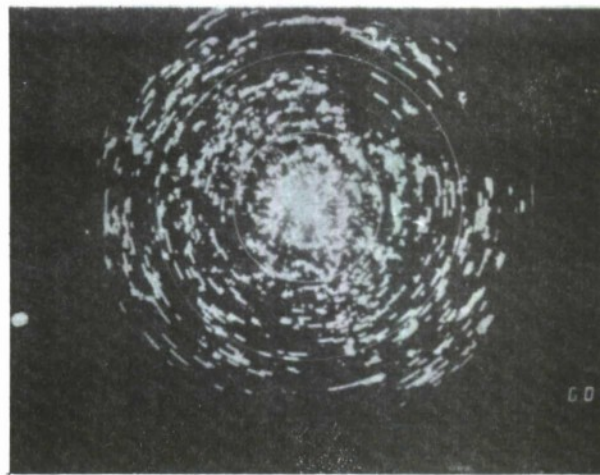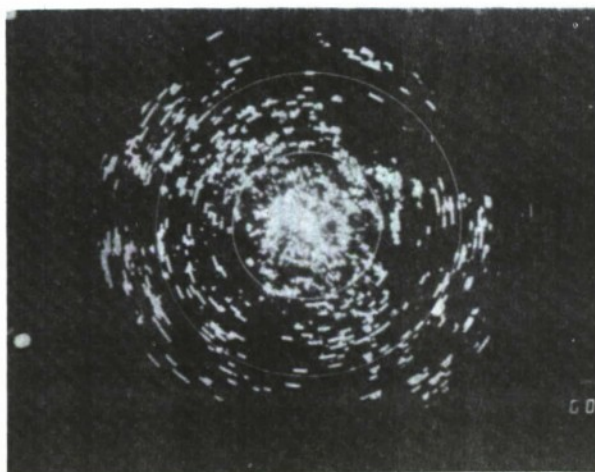
B.   MTI OFF, 10 DB ATTEN
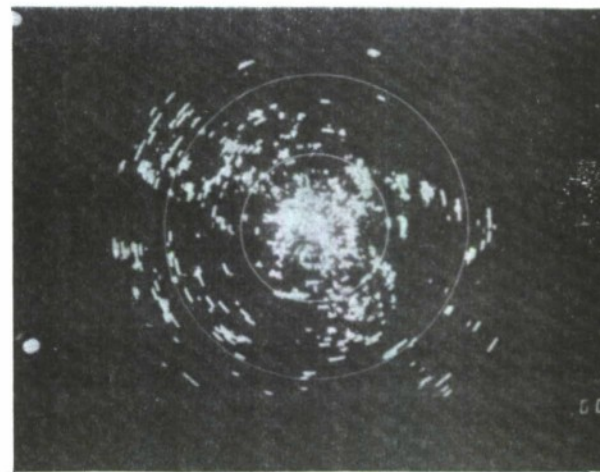
C.   MTI OFF, 20 DB ATTEN

D.   MTI OFF, 30 DB ATTEN

73-0640-BB-17

Figure 17.  Clutter Maps, East Range (Elgin Ridge)
(5 nmi Range Rings)

48
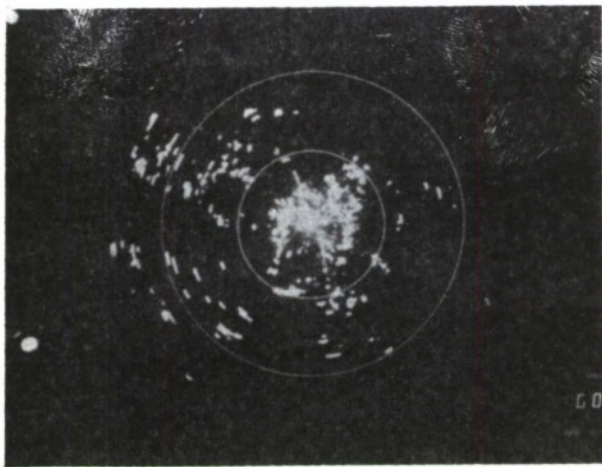
E.   MTI OFF, 40 DB ATTEN

F.   MTI OFF, 50 DB ATTEN

G.   MTI OFF, 60 DB ATTEN

H.   MTI ON, STC ON

73-0640-BB-18

Figure 17.  Continued

49
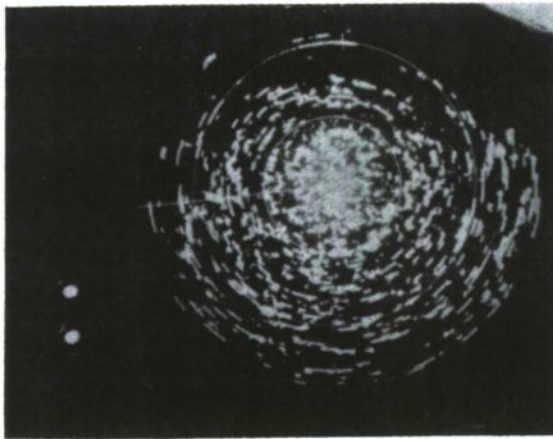
A. MTI OFF, 0 DB ATTEN

B. MTI OFF, 10 DB ATTEN

C. MTI OFF, 20 DB ATTEN

D. MTI OFF, 30 DB ATTEN

73-0640-BB-19

Figure 18. Clutter Maps, West Range (FP181)
(5 nmi Range Rings)

50
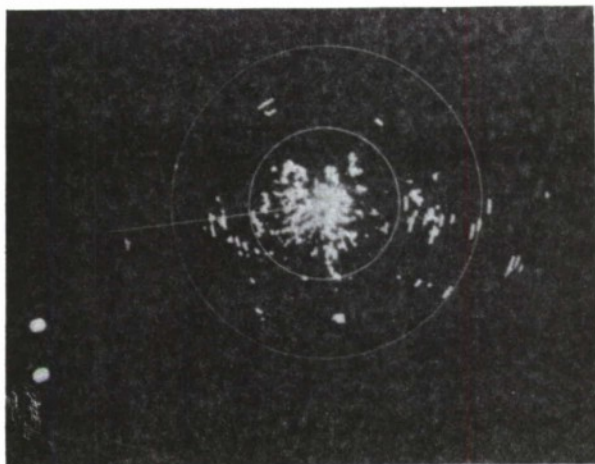
E.   MTI OFF, 40 DB ATTEN

F.   MTI OFF, 50 DB ATTEN

G.   MTI OFF, 60 DB ATTEN

H.   MTI ON, STC ON, SINGLE SCAN

73-0640-BB-20

Figure 18.   Continued
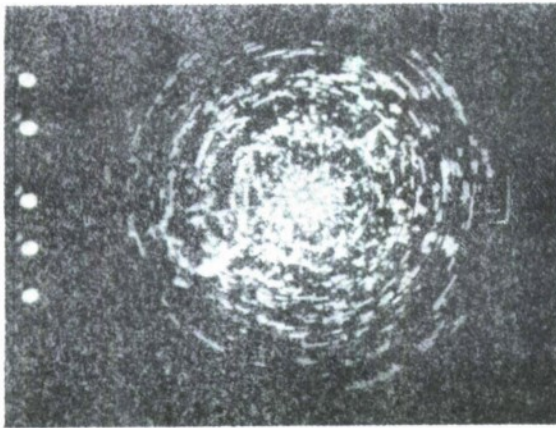
A.   MTI OFF, 0 DB ATTEN          B.   MTI OFF, 10 DB ATTEN
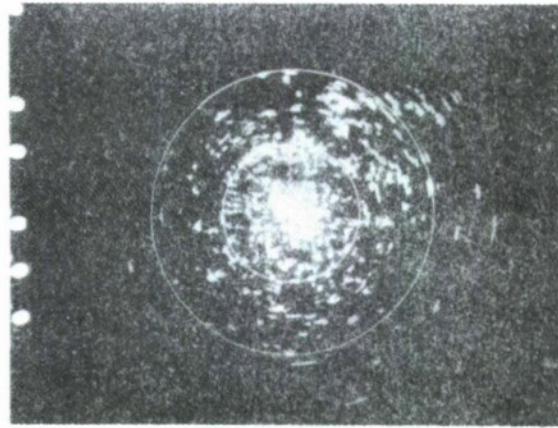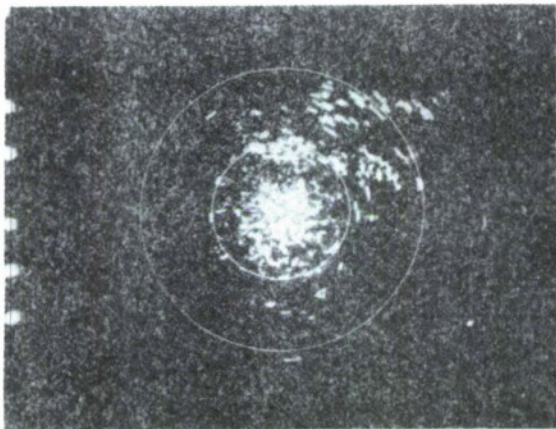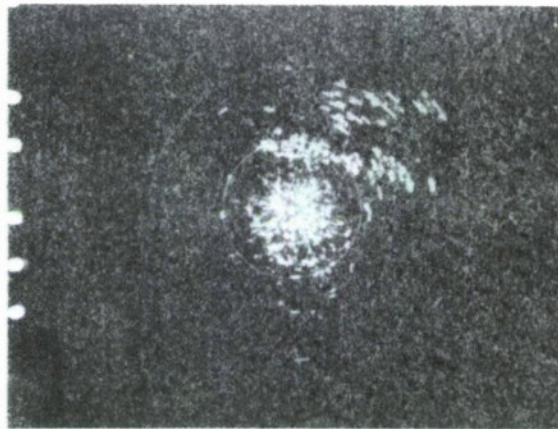
C.   MTI OFF, 20 DB ATTEN          D.   MTI OFF, 30 DB ATTEN

73-0640-BB-21

Figure 19.   Clutter Maps, Post Oak Area (POA-2)
(5 nmi Range Rings)
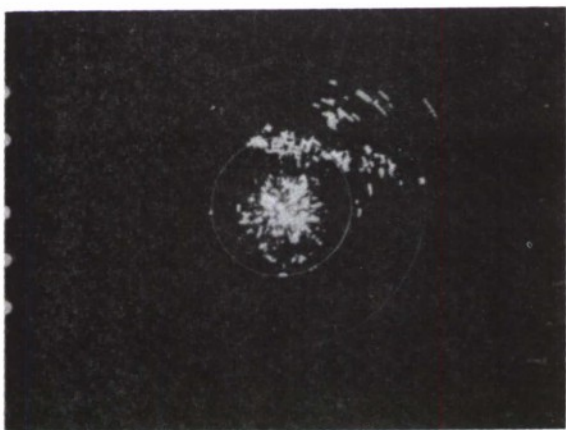
E.   MTI OFF, 40 DB ATTEN
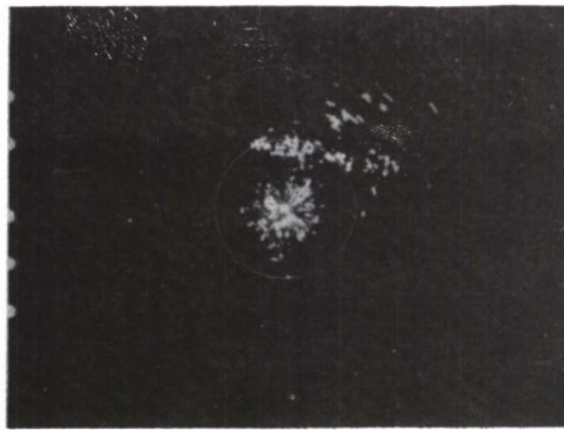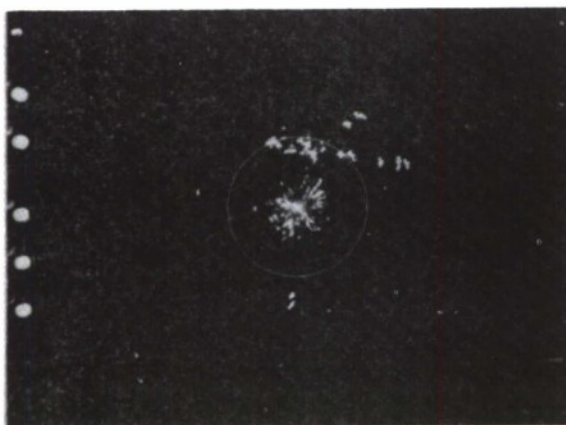
F.   MTI OFF, 50 DB ATTEN

G.   MTI OFF, 60 DB ATTEN

H.   MTI ON, STC ON, SINGLE SCAN

73-0640-BB-22

Figure 19.  Continued

# VARIATION IN FORT SILL TESTS

- Weapons

| | Range (km)* | QE (mils) | Charge |
|---|---|---|---|
| 81 mm Mortar | 5.4 | 1004, 1020 | 7 |
| 4.2-inch Mortar | 5.4 to 23.4 | 900 | 12 to 24 |
| 105 mm Howitzer | 7.3 to 13.7 | 221 to 566 | 1, 2, 3, 4, 5, 6, 7 |
| 155 mm Howitzer | 10.7 to 13.7 | 305 to 458 | 2, 4, 6 |
| 8-inch Howitzer | 16.3 to 18.1 | 518 to 671 | 6, 7 |
| 175 mm Gun | 13.7 to 31 | 266, 541, 560 | 1, 3, 2 |

* Range from Radar to Gun

- Radar Site Masking

| Site | Prominent Terrain | Variation (mils) |
|---|---|---|
| Elgin Ridge | None | 0 |
| FP181 | Signal Mountain, McKenzie Hill | 5 to 27 |
| Post Oak Area (POA-2) | QRCT and West Range Mountains | 9 to 27 |
| Gate House Area | QRCT, Signal Mountain, McKenzie Hill | 0 to 4 |

## ANNEX I.  WEAPON TEST DATA AT FORT SILL, OKLA.

| Date (1973) | Test | Weapon | FP | QE (mils) | Charge |
|---|---|---|---|---|---|
| 1/23 | 2 | 4.2 in. | 497 | 900 | 17 |
| | | | | | 12  6/8 |
| | | | | | 19  2/8 |
| | | | | | 13  2/8 |
| | | | | | 19 |
| 1/23 | 2A | 4.2 in. | 351 | 900 | 17 |
| | | | | | 20  4/8 |
| | | | | | 15  4/8 |
| | | | | | 19 |
| | | | | | 17  4/8 |
| 1/24 | 3B (Unk) | 4.2 in. | 170 | 900 | 14  4/8 |
| | | | | | 16 |
| | | | | | 17  4/8 |
| | | | | | 19  4/8 |
| | | | | | 19 |
| 1/24 | 2B | 4.2 in. | 174 | 900 | 22 |
| | | | | | 21  4/8 |
| | | | | | 24 |
| | | | | | 22  4/8 |
| | | | | | 22  4/8 |
| 1/26 | 3 (Unk) | 4.2 in. | 524 | 900 | 13  4/8 |
| | | | | | 15  4/8 |
| | | | | | 20  4/8 |
| | | | | | 17 |
| | | | | | 12  4/8 |
| 1/26 | 3A (Unk) | 4.2 in. | 415 | 900 | 12 |
| | | | | | 18  4/8 |
| | | | | | 16 |
| | | | | | 19  4/8 |
| | | | | | 16 |

| Date (1973) | Test | Weapon | FP | QE (mils) | Charge |
|---|---|---|---|---|---|
| 1/30 | 5 | 105 | 300 | 306 | 6 |
| | | | | 322 | 6 |
| | | | | 285 | 6 |
| | | | | 317 | 1 |
| | | | | 324 | 3 |
| 1/30 | 5 | 155 | 300 | 402 | 4 (Air) |
| 1/30 | 7 | 105 | 300 | 358 | 5 |
| | | | | 232 | 7 |
| | | | | 312 | 5 |
| | | | | 221 | 7 |
| | | | | | 7 |
| 1/31 | 6 | 105 | 380 | 282 | 3 |
| 1/31 | 9 (Unk) | 105 | 347 | 371 | 6 |
| | | | 303 | 357 | 5 |
| | | | 387 | 417 | 4 |
| | | | 416 | 276 | 3 |
| | | | 422 | 297 | 3 |
| | | | 421 | 264 | 2 |
| 2/2 | 4 (Unk) | 155 | 335 | 406 | 2 |
| | | 4.2 in. | | 900 | 20 |
| | | 105 | | 375 | 1 |
| | | 175 | | 266 | 1 |
| 2/6 | 10 | 105 | 116 | 462 | 4 |
| | | | | 536 | 4 |
| 2/7 | 11 (Unk) | 105 | 111 | 456 | 4 |
| | | | | 536 | 4 |
| 2/8 | 12 (Unk) | 105 | 263 | 566 | 4 |
| | | | 90 | 525 | 4 |
| | | | 106 | 449 | 4 |
| 2/14 | 15 | 175 | 250 | 541 | 3 |
| 2/15 | 16 | 175 | 208 | 560 | 3 |
| 2/21 | 15A | 8 in. | +24 | 546 | 7 |
| | | 8 in. | +24 | 618 | 6 |
| 2/22 | 16A (Unk) | 8 in. | +25 | 671 | 7 |
| | | | +23 | 518 | 7 |

| Date (1973) | Test | Weapon | FP | QE (mils) | Charge | |
|-------------|------|--------|-----|-----------|--------|-----|
| 2/27 | 13 | 155 Btry | 710 | 416 | 6 | |
| | | | | 458 | 6 | |
| | | | | 428 | 6 | |
| 2/28 | 13A (Unk) | 155 Btry | 705 | 305 | 6 | |
| | | | | 349 | 6 | |
| | | | | 331 | 6 | |
| 3/6 | 18 | 4.2 | 90 | 900 | 19 | 4/8 |
| | | | | 900 | 19 | 2/8 |
| | | 81 | 90 | 1004 | 7 | |
| | | | | 1020 | 7 | |
| 3/6 | 17 | 175 | 30 | 680 | 2 | |

ANNEX II. WEAPON LOCATION TEST SUMMARY

| Test | Radar Location | Weapon | Range (km) | Test | Location Error (M) | Blip Scan Ratio Percent | Remarks |
|---|---|---|---|---|---|---|---|
| 8 | Elgin | 155 | 10.7 | Confirm | 100 | 60 | Air Burst Observation |
| 18-2 | Gate House | 4.2 | 5.4 | Confirm | 180 | | Short Range – Heavy Clutter |
| 18-4 | Gate House | 81 | 5.4 | Confirm | 75 | | Short Range – Heavy Clutter |
| 13-1 | POA-2 | 155Btryl | 2.5 | Confirm | 280 | 70 | 0 dB Attn. in RX |
| 13-2 | POA-2 | 155Btryl | 2.5 | Confirm | 360 | | 12 dB Attn. in RX |
| 13-3 | POA-2 | 155Btryl | 2.5 | Confirm | 80 | 70 | 6 dB Attn. in RX |
| 13A-1 | POA-2 | 155Btryl | 1.1 | Locate | 280 | 80 | Significant Return when |
| 13A-2 | POA-2 | 155Btryl | 1.1 | Locate | 300 | 80 | Contrasted with Single |
| 13A-3 | POA-2 | 155Btryl | 1.1 | Locate | 280 | 80 | Piece 155 mm Howitzer |
| 13(Reg.) | POA-2 | 155 | 12.5 | Unscheduled | 80 | 70 | Unofficial Observation |
| 15A-1 | POA-2 | 8 in. | 17.4 | Confirm | 225 | 35 | |
| 15A-2 | POA-2 | 8 in. | 17.4 | Confirm | 225 | 25 | |
| 16A-1 | POA-2 | 8 in. | 18.1 | Locate | 75 | 20 | Heavy Snow Falling – 1000M Vis. |
| 16A-2 | POA-2 | 8 in. | 16.3 | Locate | 80 | 50 | Heavy Snow Falling – 1000M Vis. |
| 10-1 | FP181 | 105 | 9.8 | Confirm | 200 | 95 | No Masking |
| 10-2 | FP181 | 105 | 9.8 | Confirm | 270 | 60 | No Masking |
| 11-1 | FP181 | 105 | 9.3 | Locate | 100 | 85 | Wind Gust 50 knots, Ice, Rain |
| 11-2 | FP181 | 105 | 9.3 | Locate | 150 | 40 | Wind Gust 50 knots, Ice, Rain |
| 12-1 | FP181 | 105 | 10.7 | Locate | 290 | 70 | Wind Gust 50 knots, Ice, Rain |
| 12-2 | FP181 | 105 | 9.6 | Locate | 220 | 35 | Wind Gust 50 knots, Ice, Rain |
| 12-3 | FP181 | 105 | 8.5 | Locate | 220 | 10 | Wind Gust 50 knots, Ice, Rain |
| 4-1 | Elgin | 155 | 13.7 | Locate | 470 | | Weapon Identification Test |
| 4-2 | Elgin | 4.2 | 13.7 | Locate | 640 | | Weapon Identification Test |
| 4-3 | Elgin | 105 | 13.7 | Locate | 470 | | Weapon Identification Test |
| 4-4 | Elgin | 175 | 13.7 | Locate | 360 | | Weapon Identification Test |
| 9-1 | Elgin | 105 | 11.3 | Locate | 850 | 70 | Other Weapons Firing in Area |
| 9-2 | Elgin | 105 | 10.2 | Locate | 710 | 80 | Other Weapons Firing in Area |
| 9-3 | Elgin | 105 | 8.4 | Locate | 250 | 85 | Other Weapons Firing in Area |
| 9-4 | Elgin | 105 | 9.0 | Locate | 760 | 70 | Other Weapons Firing in Area |
| 9-5 | Elgin | 105 | 8.2 | Locate | 290 | 80 | Storm Front in Area |
| 9-6 | Elgin | 105 | 7.3 | Locate | 200 | 100 | Storm Front in Area |

| Test | Radar Location | Weapon | Range (km) | Test | Location Error (M) | Blip Scan Ratio Percent | Remarks |
|---|---|---|---|---|---|---|---|
| 5-1 | Elgin | 105 | 10.7 | Confirm | 840 | 75 | Resection Error < 100M |
| 5-2 | Elgin | 105 | 10.7 | Confirm | 950 | 80 | Resection Error < 100M |
| 5-3 | Elgin | 105 | 10.7 | Confirm | 440 | 60 | Resection Error < 100M |
| 5-4 | Elgin | 105 | 10.7 | Confirm | 50 | 60 | Resection Error < 100M |
| 7-1 | Elgin | 105 | 10.7 | Confirm | 50 | 60 | Other Weapons Firing in Area |
| 7-2 | Elgin | 105 | 10.7 | Confirm | 750 | 75 | Other Weapons Firing in Area |
| 7-3 | Elgin | 105 | 10.7 | Confirm | 50 | 60 | Other Weapons Firing in Area |
| 7-4 | Elgin | 105 | 10.7 | Confirm | 50 | 65 | Other Weapons Firing in Area |
| 2-3 | Elgin | 105 | 8.4 | Confirm | 100 | | Heavy Point Clutter |
| 2A-1 | Elgin | 4.2 | 13.4 | Confirm | 880 | 60 | Clutter Free Area |
| 2A-2 | Elgin | 4.2 | 13.4 | Confirm | 520 | 65 | Clutter Free Area |
| 2A-3 | Elgin | 4.2 | 13.4 | Confirm | 740 | 63 | Clutter Free Area |
| 2A-4 | Elgin | 4.2 | 13.4 | Confirm | 550 | 60 | Clutter Free Area |
| 2A-5 | Elgin | 4.2 | 13.4 | Confirm | 100 | 50 | Clutter Free Area |
| 2B-1 | Elgin | 4.2 | 21.9 | Confirm | 400 | | Weapon Near Signal Mountain |
| 2B-2 | Elgin | 4.2 | 21.9 | Confirm | 500 | | Weapon Near Signal Mountain |
| 2B-3 | Elgin | 4.2 | 21.9 | Confirm | 180 | 60 | Weapon Near Signal Mountain |
| 2B-4 | Elgin | 4.2 | 21.9 | Confirm | 1060 | | Weapon Near Signal Mountain |
| 2B-5 | Elgin | 4.2 | 21.9 | Confirm | 650 | | Weapon Near Signal Mountain |
| 3B-5 | Elgin | 4.2 | 23.4 | Locate | 1300 | | Trajectory Over Signal Mountain |
| 3-1 | Elgin | 4.2 | 13.6 | Locate | 410 | 100 | High Blip Scan Ratio |
| 3-2 | Elgin | 4.2 | 13.6 | Locate | 410 | 100 | High Blip Scan Ratio |
| 3-3 | Elgin | 4.2 | 13.6 | Locate | 410 | 65 | High Blip Scan Ratio |
| 3-4 | Elgin | 4.2 | 13.6 | Locate | 900 | 50 | High Blip Scan Ratio |
| 3-5 | Elgin | 4.2 | 13.6 | Locate | 150 | 85 | High Blip Scan Ratio |
| 3A-1 | Elgin | 4.2 | 8.2 | Locate | 710 | 60 | Large Point Clutter |
| 3A-2 | Elgin | 4.2 | 8.2 | Locate | 640 | 30 | Large Point Clutter |
| 3A-3 | Elgin | 4.2 | 8.2 | Locate | 540 | 30 | Large Point Clutter |
| 3A-5 | Elgin | 4.2 | 8.2 | Locate | 750 | 50 | Large Point Clutter |

## UNSUCCESSFUL LOCATION TEST SUMMARY

| Test | Radar Location | Weapon | Range (km) | Probable Cause |
|------|----------------|--------|------------|----------------|
| 14, 15, 16 | POA-2 | 175 | 31.5 | *Target Aspect-Low Radar Cross Section |
| 18-1 | Gate House | 4.2 | 5.4 | CPACS Capture - Severe Clutter |
| 18-3 | Gate House | 81 | 5.4 | CPACS Capture - Severe Clutter |
| 5-5 | Elgin | 105 | 10.7 | Tangential Trajectory - Low Radial Vel. |
| 2-1 | Elgin | 4.2 | 8.4 | CPACS Capture - Point Clutter |
| 2-2 | Elgin | 4.2 | 8.4 | CPACS Capture - Point Clutter |
| 2-4 | Elgin | 4.2 | 8.4 | CPACS Capture - Point Clutter |
| 2-5 | Elgin | 4.2 | 8.4 | CPACS Capture - Point Clutter |
| 3B-1 | Elgin | 4.2 | 23.4 | Trajectory Over Signal Mountain |
| 3B-2 | Elgin | 4.2 | 23.4 | Trajectory Over Signal Mountain |
| 3B-3 | Elgin | 4.2 | 23.4 | Trajectory Over Signal Mountain |
| 3B-4 | Elgin | 4.2 | 23.4 | Trajectory Over Signal Mountain |
| 3A-4 | Elgin | 4.2 | 8.2 | Large Point Clutter in Vicinity |

*155 mm Howtizer observed and located at 27 km during these tests.

# Weapon Locating Technique Using TPS-61 ()



QE – quadrant elevation

$R_1$, $\theta_1$ – range and azimuth of projectile at first detection

$R_2$, $\theta_2$ – range and azimuth of projectile at last detection

$L_T$ – radar observed projectile flight path length

d – distance traveled by projectile before it enters radar field of view

r – distance traveled by projectile after it enters radar field of view and before it is detected

$H_M$ – height of mash at detection range

$H_C$ – height correction for earth's curvature

$H_R$ – height of radar

$H_W$ – height of weapon

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Figure 20.  Physical Interpretation of Weapon Locating Techniques

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# ANNEX III.  COMPUTER CORRECTIONS MADE TO RAW RADAR DATA

A detailed description of the weapon-location technique will serve to show how radar data was processed in the computer to locate weapons. First the methodology will be presented, and then the actual procedure, including the data inputs to the computer, will be listed.

Step 1 -  The observed radar data ($R_1$, $\theta_1$, $R_2$, $\theta_2$) are used to calculate $L_T$ (the radar-observed projectile path length) using the law of cosines.  The physical significance of these parameters is shown in figure 20, and the PPI geometry is shown on figure 21.

Step 2 -  The next step is to find H, the height of the projectile above the weapon, when the projectile first enters the field of view of the radar.  This height, H, is composed of four components

$$H = H_M + H_R + H_C - H_\omega$$

These components are obtained in the following manner:

$H_M$ is the height measured by the radar.  Although the AN/TPS-61( ) is a 2D radar, height information can be obtained by measuring masking angles as a function of azimuth.  The masking angles, $\phi_M$ in figure 20, are determined optically during radar installation; and a table of masking angle versus azimuth is prepared.  For example, at an azimuth of $\theta_1$, the masking angle is $\phi_1$, and

$$HM_1 = R_1 \sin \phi_1$$
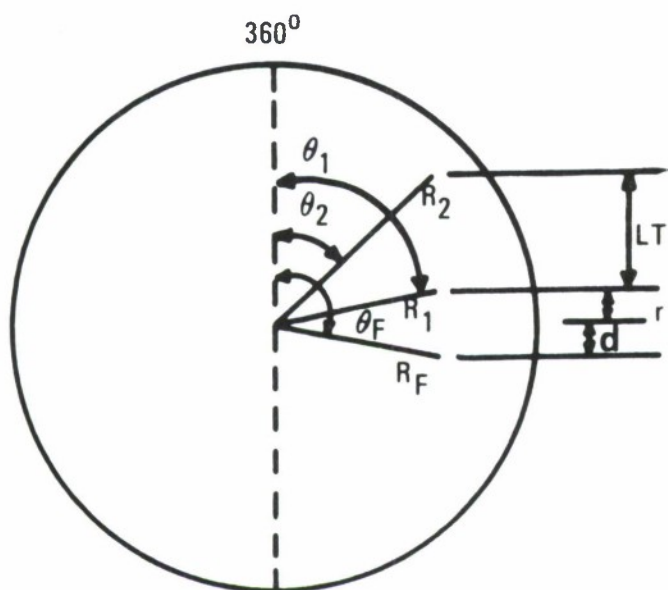
$R_1, \theta_1$ — RANGE AND AZIMUTH OF PROJECTILE AT FIRST DETECTION

$R_2, \theta_2$ — RANGE AND AZIMUTH OF PROJECTILE AT LAST DETECTION

LT — RADAR OBSERVED PROJECTILE FLIGHT PATH LENGTH

$R_F, \theta_F$ — FINAL RANGE AND AZIMUTH TO WEAPON

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Figure 21. PPI Geometry of Weapon Locating Technique

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Then $H_M$ is the height of the projectile with respect to the local horizontal. To obtain a height with respect to the weapon, the effects of earth curvature, $H_C$, has been added. The last term, $H_\omega$, is the height of the weapon above ground level. It is subtracted from the height of the radar $H_R$. An estimate of $H_\omega$ is made from a topographical map having made a gross estimate of weapon position.

Step 3 - Knowing H, then d on figure 20 can be calculated, if QE is known, from $d = H/\tan(QE)$. The variable d is the distance traveled by the projectile before it enters the field of view of the radar. The QE is found by using the $L_T$ found in step one, and the prepared firing chart shown on figure 22. The responsibility for determination of weapon class (mortar, howitzer, long range gun) is with the radar. This is determined by visual observation of the display from separation between scan intervals and the length of track. Within each class it is reasonable to assume that the type of weapon will be known from intelligence reports. To differentiate between class and type, the US Army's weapons will be illustrated.

| Weapon Class (From Radar Observations) | Weapon Type (From Intelligence Reports) |
|---|---|
| Mortars (MV $\approx$ 200 m/s) | 81 mm |
| Howitzers (MV $\approx$ 400 m/s) | 4.2 inch |
| | 8 inch |
| | 105 mm |
| | 155 mm |
| Guns (MV $\approx$ 900 m/s) | 175 mm |

For each of these weapon types, a firing chart similar to figure 22 has been prepared.
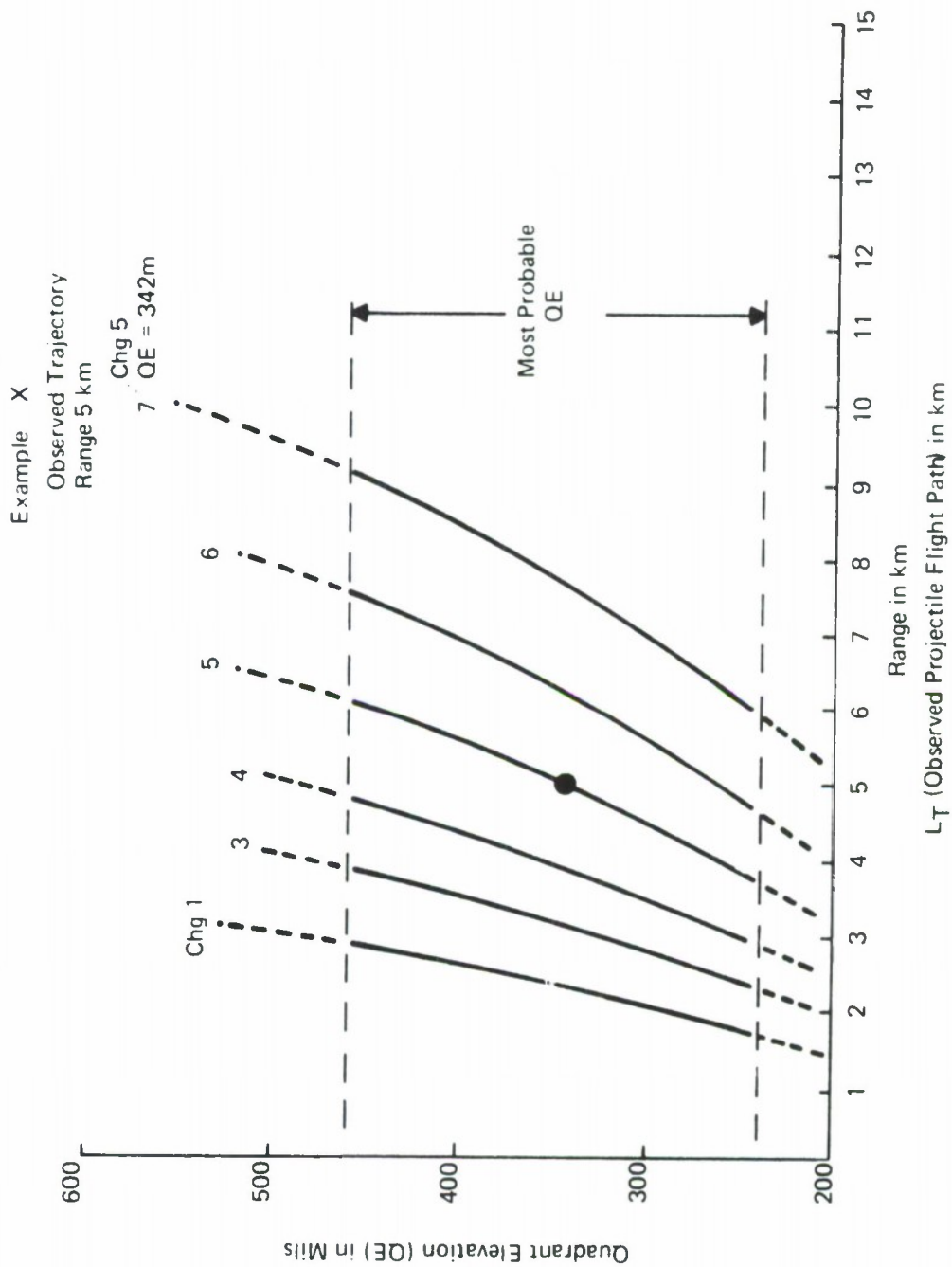
Figure 22. Estimation of QE and Charge

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On figure 22 is shown a typical example. For an $L_T$ = 5 km, then the most probable charge used was number five; for a number five charge, the QE is 342 mils. The distance d can then be found.

Step 4 - As mentioned in step 3, d is the horizontal distance that the projectile travels before it enters the field of view of the radar. However, when the radar is in the scanning mode with a scan time of 4 seconds, the radar, on an average, will observe the projectile 2 seconds after it enters the field of view. Rather than traveling a horizontal distance d before radar observation, the projectile will have traveled a distance r + d. Therefore, r (on figure 20) can be determined from

$$r = \frac{VT}{2} \left[ 1 - (0.01)^{1/N} \right] \cos (QE)$$

Where V is the initial velocity of the projectile

T is the antenna scan time = 4 seconds

N is the number of rounds observed

QE is the quadrant elevation.

The relationship shows that as N (the number of rounds observed) gets large, r goes to zero.

Also, when the radar is operated in the searchlight mode, r goes to zero, because the radar observes the projectile as soon as it enters the field of view - i.e., T = 0.

All parameters in the relationship for r are known - QE was determined from figure 22, and the charge number determines the initial velocity, V.

Step 5 -   Having found d and r, these two terms can be added to $L_T$ on figure 21 in order to find the location of the weapon. The range and azimuth to the weapon are then found by the law of cosines.

Step 6 -   Refinements in weapon location can be made by transferring the estimated position to a topographical map of the area. This will show the most probable location of a weapon emplacement near the estimated point.

Step 7 -   An iteration of the above procedure is used to refine the data. In general, one iteration is sufficient. The iteration refines previous estimates. For example, the first estimate of QE from figure 22 assumed that the total projectile flight path was $L_T$. In readlity, it was $L_T + r + d$. A further refinement can also be made in the estimate of $H_\omega$ in step 2, since the weapon postion is known more accurately. In summary, then, the weapon location sequence is the following, using the computer to perform all calculations. All computer entries, computations, table lookups, and map plotting were performed in less than 5 minutes.

### WEAPON LOCATION SEQUENCE

Step 1 -   Enter Radar Data to Computer

$R_1$, $\theta_1$    Observed coordinates of earliest reported scan (closest to weapon)

$R_2$, $\theta_2$    Observed coordinates of last reported scan (closest to impact)

N    Number of rounds observed

T    Scan period in seconds (typically 4)

$H_R$    Height of radar

$H_\omega$    Height of weapon from $R_1$, $\theta_1$ and contour map

Step 2 -   Computer Calculates Observed Flight Path Length

$$L_T = \left[ R_1^2 + R_2^2 - 2R_1 R_2 \cos(\theta_1 - \theta_2) \right]^{1/2}$$

Computer Calculates Weapon Height Difference at Earliest Detection

$$H = H_C + H_M + H_R - H_\omega$$

Step 3 -   Select QE and V from Firing Charts as a Function of Weapon and $L_T$

Step 4 -   Computer Calculates Distance Traveled Before First Possible Detection

$$d = H/\tan(QE)$$

Step 5 -   Computer Calculates Distance Traveled from First Possible Detection to Radar Observed Detection

$$r = \frac{V_T}{2} \left[ 1 - (0.01) \right]^{-1/N} \cos(QE) \quad \text{(Scan Mode)}$$

$$r = 0 \; (T = 0 \text{ if in searchlighting mode})$$

Step 6 -   Computer Range and Azimuth to Weapon

$$R_F = \left[ R_1^2 + (r+d)^2 + 2R_1(r+d) \frac{R_1 - R_2 \cos(\theta_1 - \theta_2)}{L_T} \right]^{1/2}$$

$$\theta_F = \theta_1 + \tan^{-1} \left[ \frac{(r+d) \frac{\left( R_2 \sin(\theta_1 - \theta_2) \right)}{L_T}}{R_1 + (r+d) \frac{\left( R_1 - R_2 \cos(\theta_1 - \theta_2) \right)}{L_T}} \right]$$

Step 7 -   Repeat steps 2 through 6 with Better Estimate of QE and $H_\omega$

Step 8 -   Report Final Range and Azimuth to Weapon

To summarize, the origin of the estimates is:

| Maps | Tables | Radar | Computer |
|------|--------|-------|----------|
| $H_\omega$ | $\phi_M$ | T | $H_M$ |
| $H_R$ | QE (from $L_T$) | $R_1$, $\theta_1$ | $H_C$ |
| | V (from $L_T$) | $R_2$, $\theta_2$ | H |
| | | | d |
| | | | $L_T$ |
| | | | $R_F$ |
| | | | $\theta_F$ |

ANNEX IV.  ADDITIONAL ASR TESTS
FORT SILL, OKLAHOMA

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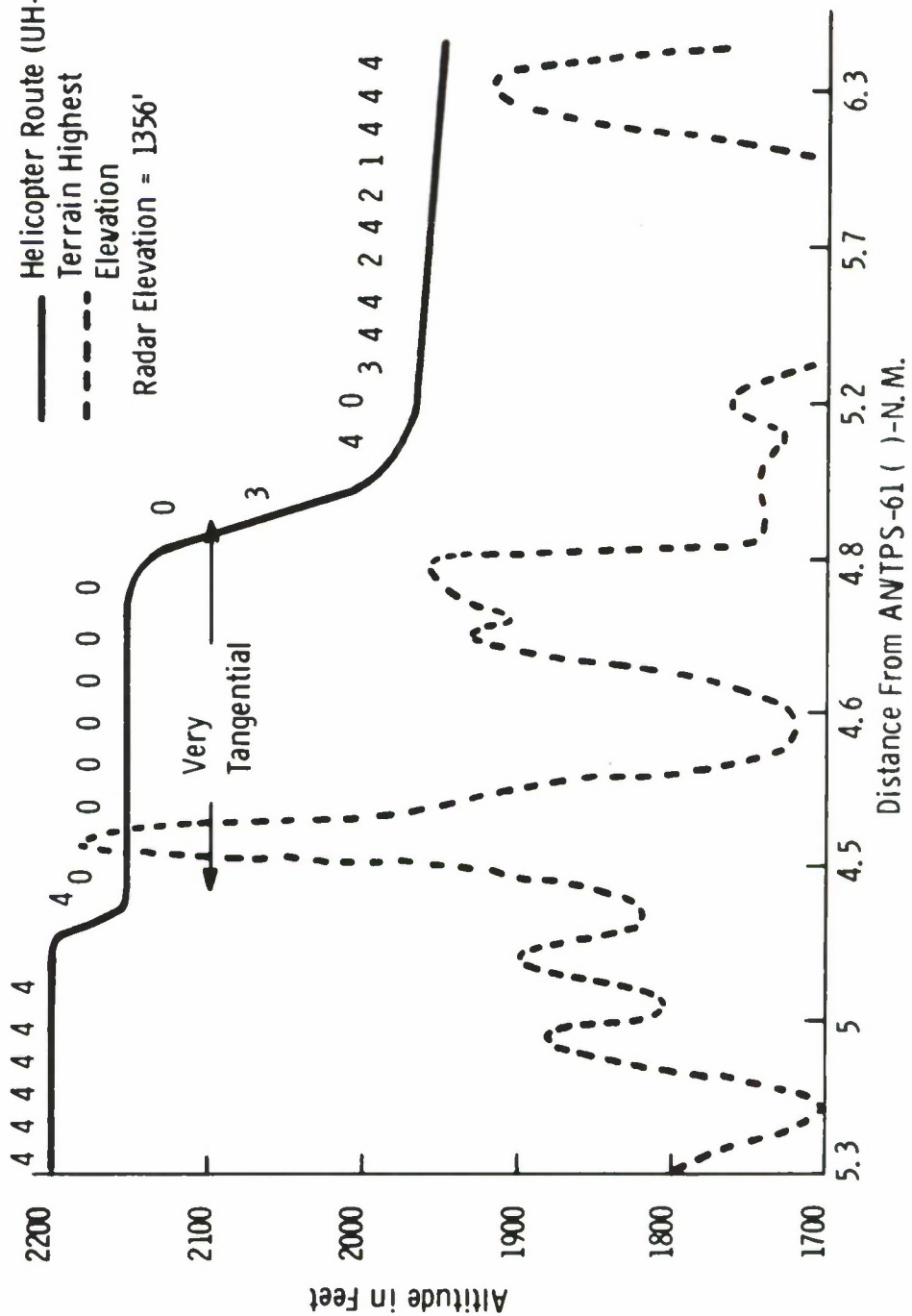
Figure 23. ASR Flight Test Data
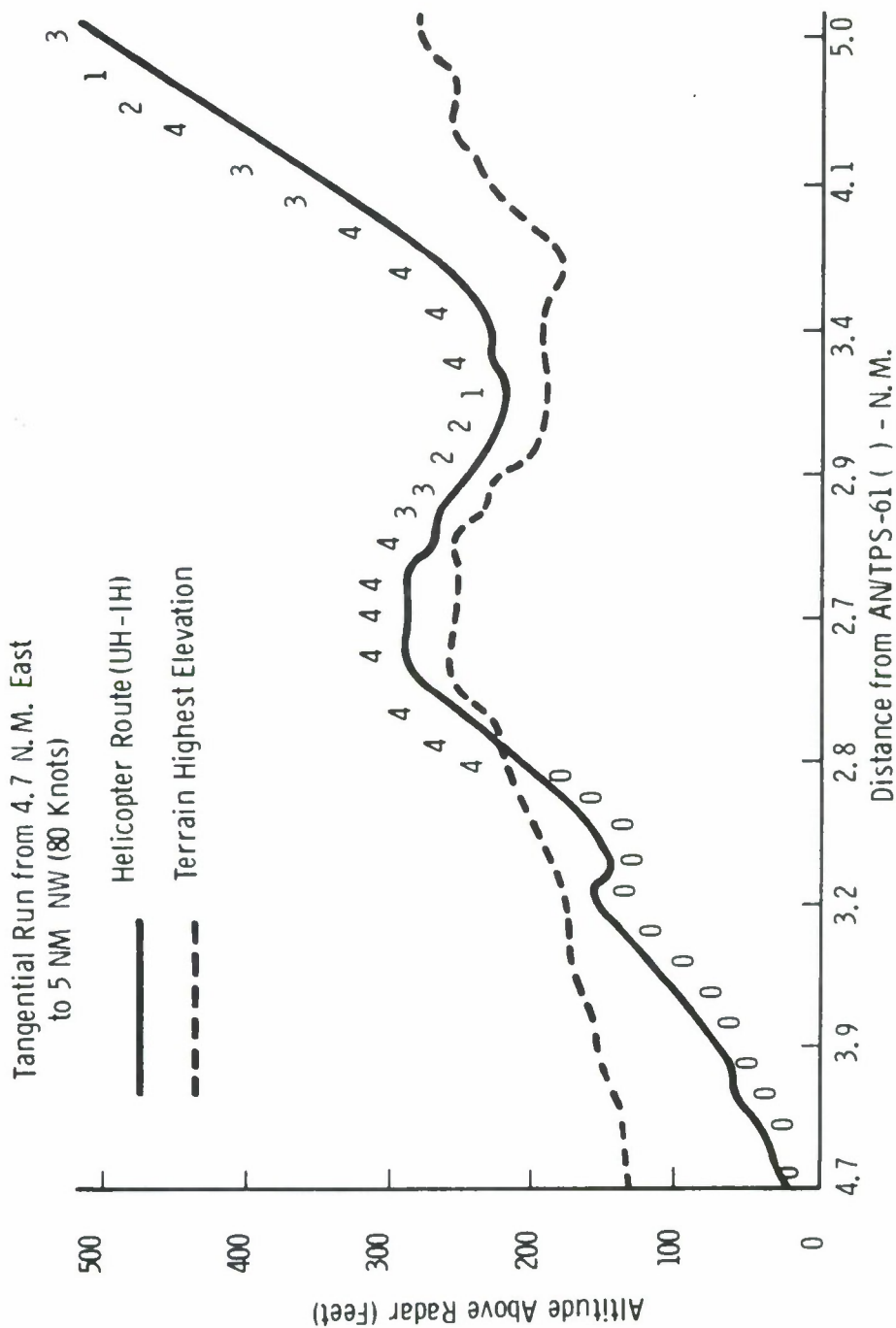
Figure 24.  ASR Flight Test Data

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## ANNEX V. FORT SILL TEST INFORMATION SHEETS (TIS)

The Test Information Sheet (TIS) is a concise one-page description of each test. It includes such information as weapon data, radar status/ mode, test description, weather conditions, and display data. Final raw radar data was recorded under the heading B SCOPE DATA, and in most circumstances is the best data for approximately the first five rounds. These sheets were filled in the same day as the conduct of mission and presented to the Land Warfare Laboratory representative the following day. The enclosed sheets are a reproduction of the originals except for typed entries rather than handwritten.

## TEST INFORMATION SHEET (RADAR DATA)

MISSION PARTICULARS

Mission No. 2
Date 1/23/73
Weather Clear
Site Elgin Ridge
*WPN 4.2" Mortar
*WPN Location (if known) FP497
Az(Mils) 497
RNG(KM) 4.52 NM-195.6°
Site Altitude(M) 391M

*GUN DATA
Charge See below
Q.E.(Mils) 900
AZ (Mils)
RADAR MODE
Z (us) 26
STC(on/off) On
N.O.B. (Deg) +3 dB
PPI Scale (NM) 7.5
Range(M)

TEST DESCRIPTION To verify 4.2" mortar location

RADAR STATUS High swept, CFA Mode

MISSION REMARKS Unable to observe 1st part of track consistently
due to large point clutter at FP (affected CPACS Mode)

MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG AZ | B SCOPE DATA | | | WPN/TGT FIND | REMARKS |
|---------|---------|---------|---------|---------|---------|---------|---------|
| | | | RNG | AZ | SCALE | | |
| 1-5 (Ch 17) | SCN | | 3.95 NM | 197° | 6 m1x20° | Tgt | B/S data was marginal and only useful for cueing, impact from scope shown at left. |
| 6-10 Charge (12 6/8) | SCN | | 4.1 NM | 197.1° | 6 m1x20° | Tgt. | See note above. |

*Data to be filled in after mission when required per test.

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## TEST INFORMATION SHEET (RADAR DATA)

**MISSION PARTICULARS**

Mission No. 2
Date 1/23/73
Weather Clear
Site Elgin Ridge
*WPN 4.2" Mortar
**WPN Location (if known) FP 497
Az(Mils) 4.52 NM-195.6°
RNG(KM)
Site Altitude(M) 391M

*GUN DATA
Charge See below
Q.E.(Mils) 900
AZ (Mils)

RADAR MODE
Z (us) 4
STC(on/off) On
N.O.B. (Deg) +3 dB
PPI Scale (NM) 7.5 NM
Range(M)

**TEST DESCRIPTION** To verify 4.2" mortar location

**RADAR STATUS** High swept, CFA

**MISSION REMARKS** Backup mode used (4 us) with STC due to **large** pt. clutter at FP.

### MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | B SCOPE DATA RNG | AZ | SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 11-15 " (Ch 19-2/8) | SCN " | | | 4.5 NM | 195° | 6 NM×20° | WPN TGT | Observed 3 hits & impact on scope (error = 100M) |
| 16-20 (Ch 13-2/8) | SCN | | | 2.95 NM | 196.6° | | TGT | B/S marginal & useable for cueing. Impact from scope shown at left. |
| 20-25 (Ch 19) | SCN | | | 3.1 NM | 203.6° | | TGT | B/S marginal and useable for cueing - All impacts observed. |

*Data to be filled in after mission when required per test.

73-0640-VB-28

## TEST INFORMATION SHEET (RADAR DATA)

### MISSION PARTICULARS

**\*GUN DATA**

Charge ___
Q.E. (Mils) ___
AZ (Mils) Unk

Mission No. Tgts. of oppor.
Date 1/23/73
Weather Clear
Site Eglin Ridge
\*WPN 105 mm Howitzer
\*WPN Location (if known)
Az(Mils) ___
RNG(KM) ___
Site Altitude(M) ___

RADAR MODE
Z (us) 26
STC(on/off) On
N.O.B. (Deg) ±3db
PPI Scale (NM) 15
Range(M) ___

### TEST DESCRIPTION

Observed numerous 105 mm Howitzer rounds between 4.2" scheduled mortar fire. Virtually 100% B/S seen.

RADAR STATUS  High swept, CFA

MISSION REMARKS  Noted that it was easy to distinguish between mortar fire and Howitzer fire by vel. spacing.

### MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | PPI DATA AZ | B SCOPE DATA RNG NM | B SCOPE DATA AZ | B SCOPE DATA SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| - | SCN | | | 7.75 <br> 6.5 | 195° <br> 194° | 6 x 20 <br> " | WPN <br> TGT | 100% B/S from daily firing sched. FP=510 (student prob. GOF152) at 7.9 NM 196° |
| - | SCN | | | 8.1 | 196° | " | WPN | 100% B/S from daily diring sched. FP=509 (student prob. GOF152) at observed range. |

\*Data to be filled in after mission when required per test.

73-0640-VB-29

## MISSION PARTICULARS

Mission No. __2A__
Date __1/23/73__
Weather __Clear__
Site __Elgin Ridge__
*WPN __4.2" Mortar__
*WPN Location (if known) __FP 351__
Az(Mils) ____ RNG(KM) __7.2 NM at 185°__
Site Altitude(M) __391__

*GUN DATA
Charge __See below__
Q.E.(Mils) __900__
AZ(Mils) _____
RADAR MODE
Z (us) __26 us__
STC(on/off) __Off__
N.O.B.(Deg) __+3 dB__
PPI Scale (NM) __15__
Range(M) _____

TEST DESCRIPTION __To verify 4.2" mortar location__

Note: __All known fire and impact pts. were treated as unknown until est. were made.__

RADAR STATUS __High swept, VFA mode. B-scope start of sector =__
__180° & 3.5 NM__

MISSION REMARKS __Computer runs were made for 1-5, 11-15, and 21-25 and are shown on separate sheets. Rounds fired at 30 sec. intervals.__

### MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | B SCOPE DATA RNG | AZ | SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 1-5 " (Ch 17) | SCN " | | | 6.9 NM 5.7 NM | 187.1° 190° | 6mix20° " | WPN TGT | Observed 5 rounds. Real time radar est. shown at left. (Act. WPN Location = 7.2 NM at 185°) (Mortar fired at impact pt. 388) Observed 60% B/S on scope. |
| 6-10 " (Charge 20-4/8.) | SCN " | | | 7.1 NM 6.5 NM | 187° 190° | 6x20 " | WPN TGT | Observed 5 rounds. Real time radar est. shown at left. Mortar fired at impact pt. 386). Observed 65% B/S on scope. |

*Data to be filled in after mission when required per test.

73-0640-VB-30

## TEST INFORMATION SHEET (RADAR DATA)

MISSION PARTICULARS

Mission No. 2A
Date 1/23/73
Weather Clear
Site Elgin Ridge
*WPN 4.2" Mortar
**WPN Location (if known) FP351
Az(Mils) _____
RNG(KM) (7.2 NM at 185°)
Site Altitude(M) 391M

TEST DESCRIPTION To verify 4.2" mortar location

Note: All known fire and impact points were treated as unknown until est. were made.

*GUN DATA
Charge See below
Q.E.(Mils) 900
AZ(Mils) _____

RADAR MODE
Z (us) 26
STC(on/off) Off
N.O.B. (Deg) +3 dB
PPI Scale (NM) 15
Range(M) _____

RADAR STATUS High swept, CFA mode, B-scope start sector = 180° and 3.5 NM

MISSION REMARKS Computer runs were made for 1-5, 11-15, and 21-25 and are shown on separate sheets. Rate of fire 30 sec. between rds.

MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | B SCOPE DATA RNG | AZ | SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 11-15 " (Ch 15-4/8) | SCN " | | | 6.9 NM 5.9 NM | 187° 190.5° | 6NMx20° " | WPN TGT | Observed 5 rds. Real time radar est. shown at left. Mortar fired at impact pt 395. Observed 63% B/S on scope |
| 16-20 " (Ch 19) | SCN " | | | 6.9 NM 6.3 NM | 185° 189.5° | 6x20 " | WPN TGT | Observed 5 rds. Real time radar est. shown at left. Mortar fired at impact pt. 349. Observed 60% B/S on scope. |

*Data to be filled in after mission when required per test.

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## TEST INFORMATION SHEET (RADAR DATA)

### MISSION PARTICULARS

Mission No. __2A__
Date __1/23/73__
Weather __Clear__
Site __Elgin Ridge__
*WPN __4.2" Mortar__
**WPN Location (if known)
Az(Mils) __FP351__ (7.2 NM at 185°)
RNG(KM) __391M__
Site Altitude(M) __391M__

*GUN DATA
Charge __See below__
Q.E,(Mils) __900__
AZ (Mils) _____

RADAR MODE __26__
Z (us) _____
STC(on/off) __Off__
N.O.B. (Deg) __+3 dB__
PPI Scale (NM) __15__
Range(M) _____

### TEST DESCRIPTION To verify 4.2" mortar location

Note all known fire and impact pt. were treated as unknown until est. were made.

RADAR STATUS __High swept, CFA mode, B-scope start of sector =__ __180°__ and 3.5 NM.

MISSION REMARKS __Computer runs were made for 1-5, 11-15, and 21-25 and are shown on separate sheets. Rounds fired at 30 sec. interval.__

### MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG AZ | | B SCOPE DATA RNG | AZ | SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 21-25 (Ch 17-4/8) | SCN | | | 7.2 NM | 185° | 6NMx20° | WPN | Observed 5 rds. Real time radar est. shown at left. (Act. Wpn location = FP351  7.2NM at 185°) (Mortar fired at impact pt. 327.) Observed 51% B/S on scope. |

*Data to be filled in after mission when required per test.

73-0640-VB-32

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## TEST INFORMATION SHEET (RADAR DATA).

### MISSION PARTICULARS

Mission No. 2B
Date 1/24/73
Weather Clear
Site Elgin Ridge
*WPN 4.2" Mortar
**WPN Location (if known)
Az(Mils) FP174
RNG(KM) Daly Hill
Site Altitude(M) 391M

### *GUN DATA

Charge
Q.E.(Mils)
AZ (Mils) 900

RADAR MODE
Z (us) 26
STC(on/off) On
N.O.B. (Deg) +3 dB
PPI Scale (NM) 15
Range(M)

### TEST DESCRIPTION  To verify 4.2" Mortar Location in clutter at long range.

RADAR STATUS  High swept, CFA mode.

MISSION REMARKS  B-scope sector set for 7 NM, 230° start.

B/S data averaged  55% for all rounds

### MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | B SCOPE DATA RNG | AZ | SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 1-5 " (Ch 14-4/8) | SCN " | | | 11.5 NM 10.45 | 237° 240° | 6x20° " | WPN TGT | WPN and TGT impact points composite of 5 rds. See computer reduction sheets for refined answer. |
| 6-10 " (Ch 16) | SCN " | | | 11.5 10.4 | 237° 241° | 6x20° " | WPN TGT | See above Poor B/S |
| 11-15 " (Ch 17-4/8) | SCN " | | | 11.8 10.75 | 236° 243° | 6x20° " | WPN TGT | See above 60% B/S |

*Data to be filled in after mission when required per test.

73-0640-VB-33

TEST INFORMATION SHEET (RADAR DATA)

## MISSION PARTICULARS

Mission No. __2B__
Date __1/24/73__
Weather __Clear__
Site __Elgin Ridge__
WPN __4.2" Mortar__
WPN Location (if known) __FP174__
Az(Mils) _____ __Daly Hill__
RNG(KM) _____
Site Altitude(M) __391__

## GUN DATA

Charge _____
Q.E.(Mils) __900__
AZ(Mils) _____

RADAR MODE
Z (us) __26__
STC(on/off) __On__
N.O.B. (Deg) __+3 dB__
PPI Scale (NM) __15__
Range(M) _____

**TEST DESCRIPTION** To verify 4.2" Mortar in clutter at long range.

RADAR STATUS __High Swept, CFA__

MISSION REMARKS __B-Scope sector set for 7 NM, 230° start.__
__B/S data averaged   55% for all rounds.__

## MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | B SCOPE DATA RNG | AZ | SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 16-20 (Ch 19-4/8) | SCN " | | | 11.2 / 10.45 | 238° / 242° | 6x20° " | WPN TGT | Missed 1st part of track. |
| 21-25 (Ch 19) | SCN " | | | 11.35 / 10.2 | 237° / 241° | 6x20° " | WPN TGT | Weapon and tgt. impact pts. composite of 5 rds. See computer reduction for refined data. |

*Data to be filled in after mission when required per test.

73-0640-VB-34

## TEST INFORMATION SHEET (RADAR DATA)

**MISSION PARTICULARS**

Mission No. 3
Date 1/24/73
Weather Clear
Site Elgin Ridge
*WPN 4.2" Mortar
*WPN Location (if known)
  Az(Mils) Unk
- RNG(KM) Unk
Site Altitude(M) 391M

**TEST DESCRIPTION** To locate 4.2" mortar at long range in clutter
(w/o apriori knowledge)

**RADAR STATUS** High swept, CFA mode

**MISSION REMARKS** 4.2" observed with very low blip scan ratio (not adequate for tactical cueing or WPN location) – Howitzers observed in same general area all adequate for Wpn location.

*GUN DATA
Charge Unk
Q.E.(Mils) 900
AZ (Mils) Unk

RADAR MODE
Z (us) 26
STC(on/off) On
N.O.B. (Deg) +3 dB
PPI Scale (NM) 15
Range(M)

**MISSION DATA**

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | B SCOPE DATA RNG | AZ | SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 1-25 | SCN | | | 10.55 | 231.0 | 6x20 | WPN | Observed in sequences 3,4,5 105 MM How from FP 70 (300M error) B.S.R = 90% |
| | | | | 13.0 | 248 | 6x20 | WPN | Observed in sequences 1,2 and between sequences – Probable fire from 105MM How at FP628 (adequate for cueing) B.S.R.=80% |
| | | | | 12.75 | 243 | 6x20 | WPN | Observed in sequence 2.3 How. fire (FP unknown) (Adequate for cueing) B.S.R. = 80% |
| | | | | 11.75 | 237.4 | 6x20 | WPN | *Observed during last sequence–Declared 4.2" because of contrast with above weapons not deemed adequate for cueing or location. Marginal B.S.R. 4.2" declared 4620 3545.Computer not used due to inadequate number of hits. |

*Data to be filled in after mission when required per test.

* 4.2" located at F.P. 169 (per T. Olon) after mission report error 1.3 KM.

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## TEST INFORMATION SHEET (RADAR DATA)

**MISSION PARTICULARS**

Mission No. 3
Date 1/26/73
Weather Clear
Site Eglin Ridge (445)
WPN 4.2" Mortar
WPN Location (if known) Unk
   Az(Mils)
   RNG(KM)
Site Altitude(M) 391

**TEST DESCRIPTION** To locate 4.2" mortar at moderate range

**\*GUN DATA**

Charge
Q.E.(Mils) 900
AZ (Mils)

**RADAR MODE**

Z (us) 26
STC(on/off) On
N.O.B. (Deg)+3db
PPI Scale (NM) 10 NM
Range(M)

**RADAR STATUS** High swept, CFA B-Scope set at 2 NM/175°

**MISSION REMARKS** Attached computer summary sheets give computer location. Clutter was effectively cancelled in general fire area.

**MISSION DATA**

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | B SCOPE DATA RNG (NM) | AZ | SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 1-5 | SCN | | | 7.55 | 181° | 6°x20° | WPN | B/S Ratio = 100% |
| | | | | 6.5 | 187° | " | TGT | |
| 6-10 | SCN | | | 7.55 | 181° | " | WPN | B/S = 100% |
| | | | | 6.5 | 190° | " | TGT | |
| 11-15 | SCN | | | 7.55 | 181° | " | WPN | B/S = 65% |
| | | | | 6.05 | 193° | " | TGT | |
| 16-20 | SCN | | | 6.95 | 184° | " | WPN | B/S = 50% |
| | | | | 6.2 | 189° | " | TGT | |
| 21-25 | SCN | | | 7.4 | 181° | " | WPN | B/S = 85% |
| | | | | 6.2 | 185.5° | " | TGT | |

\*Data to be filled in after mission when required per test.

Actual WPN Location = FP524 (given after test)

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TEST INFORMATION SHEET (RADAR DATA)

MISSION PARTICULARS

Mission No. 3A
Date 1/26/73
Weather Clear
Site Eglin Ridge (445)
WPN 4.2" Mortar
WPN Location (if known)
Az(Mils) Unk
RNG(KM)
Site Altitude(M) 391 m

*GUN DATA

Charge
Q.E.(Mils) 900
AZ (Mils)
RADAR MODE*
Z (us) 26
STC(on/off) On
N.O.B. (Deg) +3db
PPI Scale (NM) 10NM
Range(M)

TEST DESCRIPTION  To locate 4.2" Mortar at short range

RADAR STATUS  Hi swept, CFA - Rds 21-25 used 4 us p.w.

MISSION REMARKS  See computer sheets for computed data

Helicopter in general area during firein - also 105 nm rounds were observed in firing area. Lge. pt. clutter to left of fp.

MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | RNG | 2NM at 180° B SCOPE DATA AZ | SCALE | WPN/TGT FIND | REMARKS |
|---------|-------------------|--------------|-----|------|------|-------|----------|---------|
| 1-5 | SCN | | | 4.7 | 191° | 6 x 20° | WPN | 60% B/S |
| | | | | 3.2 | 196° | " | TGT | |
| 6-10 | SCN | | | 4.4 | 192° | " | WPN | 30% B/S |
| | | | | 3.5 | 193° | " | TGT | |
| 11-15 | SCN | | | 4.55 | 191° | " | WPN | 30% B/S |
| | | | | 3.8 | 197° | " | TGT | |
| 16-20 | SCN | | | | | | | Not valid for scoring |
| 21-25 | SCN | | | 4.55 | 192° | " | WPN | |
| | | | | 2.45 | 192.5° | " | TGT | |

*Data to be filled in after mission when required per test.

Actual wpn location given as 200 yds east of FP415.

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## TEST INFORMATION SHEET (RADAR DATA)

### MISSION PARTICULARS

Mission No. _____
Date 1/26/73
Weather Clear
Site Eglin Ridge
WPN 105 mm Howitzer
WPN Location (if known)
Az(Mils)Calculated to be 509 or 510
RNG(KM) FP509 or 510
Site Altitude(M) 391

*GUN DATA
Charge _____
Q.E.(Mils) _____
AZ (Mils) _____
RADAR MODE
Z (us) 26
STC(on/off) On
N.O.B. (Deg) 3 db
PPI Scale (NM) 10
Range(M)

TEST DESCRIPTION Tracked tgts of opportunity (105 mm Howitzer) Probable fire point = 509 or 510 located at 795 NM 195° (daily schedule showed 105's firing at this point student prob. (GOT 152 (27 Jan 73)
RADAR STATUS High swept

MISSION REMARKS The following data on 105 mm Howitzers (tgts of opportunity) was recorded during scoring of mission 3A.

### MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | PPI DATA AZ | B SCOPE DATA RNG | B SCOPE DATA AZ | SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| | SCN | | | 7.55 / 5.75 | 195° / 198° | 6 x 20° | WPN / TGT | 100% B/S observed during series 4 (rds 16-20) of test 3A. Noted helicopter in area |
| | SCN | | | 7.4 / 5.75 | 194° / 198° | " / " | | 100% B/S observed during 30 extra rounds of 4.2" mortar fire at end of test 3A WPN was 105 mm Howitzer |
| | SCN | | | 6.5 / 5.6 | 191° / 193° | " / " | | 80% B/S observed during 30 extra rounds of 4.2" mortar fire at end of Test 3A WPN was 105 mm Howitzer |

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*Data to be filled in after mission when required per test.

# TEST INFORMATION SHEET (RADAR DATA)

## MISSION PARTICULARS

Mission No. _____
Date __1/26/73__
Weather __Clear__
Site __Eglin Ridge__
**WPN __105 mm Howitzer__
***WPN location (if known)
  Az(Mils) _____
  RNG(KM) _____
Site Altitude(M) __391 m__

## TEST DESCRIPTION  To track 30 additional rounds of 4.2"

mortar fire at conclusion of test 3A.

RADAR STATUS __Hi swept CFA for__ __20 rds, Totem Pole__

only for __10 rds (at 26 us)__

MISSION REMARKS __Found out after fire & scoring these__

rounds that they were fired from same point as test 3A.

### *GUN DATA

Charge _____
Q.E. (Mils) _____
AZ (Mils) _____

### RADAR MODE

Z __4 us__ (us)
STC(on/off) __On__
N.O.B. (Deg) __3 db__
PPI Scale (NM) __10__
Range(M) _____

## MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | RNG | B SCOPE DATA AZ | SCALE | WPN/TGT FIND | REMARKS |
|---------|----------|---------|----|-----|---------|-------|---------|---------|
| 1-30 | SCN | | | 4.4 | 190° | 6 x 20 | WPN | Observed 80% B/S in 4 us |
| | | | | 3.5 | 195° | " | TGT | CFA mode. Could not see rounds in Totem Pole only mode. Good Tracks Detectibility on these rounds much better than those during test 3A. Reason unknown. Note also fire point range and azimuth corresponds almost exactly with test 3A. |

*Data to be filled in after mission when required per test.

73-0640-VB-39

## TEST INFORMATION SHEET (RADAR DATA)

### MISSION PARTICULARS

Mission No. __8__
Date __1/30/73__
Weather __Clear, Windy__
Site __Elgin Ridge__
*WPN __155 mm Howitzer__
**WPN Location (if known) __FP300__
  Az(Mils) _____
  RNG(KM) _____
Site Altitude(M) __391__

### *GUN DATA

Charge __4 green__
Q.E.(Mils) _____
AZ(Mils) _____

RADAR MODE __26__
Z (us) _____
STC(on/off) __ON__
N.O.B. (Deg) __+3 db__
PPI Scale (NM) __15__
Range(M) _____

### TEST DESCRIPTION  To observe radar signature of 155 mm

Howitzer airburst at low Q.E. (402 mils) (Burst at
20 meter alt.   Tgt = Pt 437 t. of flt ∠ 23 sec.

RADAR STATUS __Hi swept 26 us__

MISSION REMARKS   For comparison, Rds 5 & 6 were observed

in 4 us mode.

Note:  Radar data not reduced on computer.

### MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | B SCOPE DATA RNG NM | AZ | SCALE 2 NM I 94° | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 1-10 | SCN | | | 5.7 | 210° | 6x20° | WPN | Data is composite of all ten rounds. B/S varied from 100% to 20%. Burst was quite unique & lasted for 4 scans on all rounds. |
| | | | | 2.5 | 206° | " | TGT | WPN/TGT location based on longest track (1st & last point) Impact (Burst) occurred at Pt 437 ∴ 2.6 NM, 204° Radar error in WPN location ∠50 meters |

*Data to be filled in after mission when required per test.

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## TEST INFORMATION SHEET (RADAR DATA)

### MISSION PARTICULARS

Mission No. __7__
Date __1/30/73__
Weather __Clear, Windy__
Site __Elgin Ridge__
*WPN __105 mm Howitzer__
**WPN Location (if known) __FP300__
  Az(Mils) _____
  RNG(KM) _____
Site Altitude(M) __391 m__

### TEST DESCRIPTION  __Confirm 105 mm Howitzer location__

__firing 5 rds. to each of 4 impact pts.__

### RADAR STATUS  __Hi swept, CFA__

### MISSION REMARKS  __Noted another 105/155 Howitzer firing__

__on same general azimuth during mission (particularly__

__during series 3)  FP = 300. Impact shown in remarks__

### *GUN DATA

| | |
|---|---|
| Charge | __See below__ |
| Q.E.(Mils) | |
| AZ (Mils) | |
| RADAR MODE | |
| Z (us) | __26__ |
| STC(on/off) | __On__ |
| N.O.B. (Deg) | __+3 db__ |
| PPI Scale (NM) | __15__ |
| Range(M) | |

### MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | PPI DATA AZ | B SCOPE DATA RNG NM | B SCOPE DATA AZ | SCALE 2NM=194° | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 1-5 CH5,QE358 | SCN " | | | 5.75 2.75 | 210.5 210.5 | 6x20° " | WPN TGT | 60% B/S  ≮ T of F.= 21 |
| 6-10 CH7,QE232 | SCN | | | 5.2 2.4 | 210.0 204 | " " | WPN TGT | 75% B/S  ≮ T of T.= 19 |
| 11-15 CH5,QE312 | SCN | | | 5.7 2.9 | 210 204 | " " | WPN TGT | 60% B/S  ≮ T of Flt=19 |
| 16-20 CH7,Q221 | SCN | | | 5.75 2.4 | 210 200 | " " | WPN TGT | 65% B/S  ≮ T of Flt=18 |

Note:  All B/S are avg. of
5 rounds in each series
WPN & TGT pts are closest
detection and last detection
for each series

*Data to be filled in after mission when required per test.

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# TEST INFORMATION SHEET (RADAR DATA)

## MISSION PARTICULARS

Mission No. 5
Date 1/30/73
Weather Clear, Windy
Site Elgin Ridge
*WPN 105 How. (M102)
**WPN Location (if known) FP300
Az(Mils)
RNG(KM)
Site Altitude(M) 391

## *GUN DATA

Charge See below
Q.E.(Mils) See below
AZ(Mils)

## RADAR MODE

Z (us) 26
STC(on/off) on
N.O.B. (Deg) +3 db
PPI Scale (NM) 15
Range(M)

**TEST DESCRIPTION** Three rounds to each of five impact prints (NAA424, 450, 410; SAA 307, 319) to measure ability to triangulate on weapon at FP300.

**RADAR STATUS** Hi swept, CFA

**MISSION REMARKS** Impact points in SAA from FP300 were almost tangential to radar and affected B/S on these rounds also very low charges & short range to these points.

## MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | PPI DATA AZ | B SCOPE DATA RNG | B SCOPE DATA AZ | B SCOPE DATA SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 1-3 CH 6,QE306 | SCN | | | 5.30 | 211° | 6x20 | WPN | 75% B/S composite on 3 rds. with best end point extremes used for wpn & tgt location. TGT at Pt 424 |
| | " | | | 2.35 | 200° | " | TGT | |
| 4-6 CH6,QE322 | SCN | | | 5.0 | 210° | " | WPN | 80% B/S TGT at Pt 450 |
| | " | | | 2.3 | 203° | " | TGT | See note above for Rd 1-3 |
| 7-9 CH6,QE285 | SCN | | | 5.5 | 211° | " | WPN | 60% B/S Tgt at Pt. 410 |
| | " | | | 3.5 | 210.5° | " | TGT | See note above for Rd 1-3 |
| 10-12 CH1,QE317 | SCN | | | 5.8 | 211° | " | WPN | 60% B/S Tgt at Pt 307 |
| | " | | | 5.6 | 199° | " | TGT | B/S marginal due to tangential path |

*Data to be filled in after mission when required per test.

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(CONT)

## TEST INFORMATION SHEET (RADAR DATA)

### MISSION PARTICULARS

Mission No. _____
Date _____
Weather _____
Site _____
*WPN _____
**WPN Location (if known)
Az(Mils) _____
RNG(KM) _____
Site Altitude(M) _____

### TEST DESCRIPTION

*GUN DATA

Charge _____
Q.E.(Mils) _____
AZ (Mils) _____

RADAR MODE _____
Z (us) _____
STC(on/off) _____
N.O.B. (Deg) _____
PPI Scale (NM) _____
Range(M) _____

RADAR STATUS _____

MISSION REMARKS _____

### MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | B SCOPE DATA RNG NM | AZ | SCALE 6x20° | WPN/TGT FIND | REMARKS |
|---------|-------------------|--------------|----|---------------------|----|-------------|--------------|---------|
| 13-15 CH3,QE324 | SCN " | | | See note (remarks | | 6x20° " | WPN TGT | 50% B/S data OK for cueing poor for WPN loc. on all 5 series B/S data is avg. for 3rds some tracks were 100% others only 1 or 2 hits (series 5 for example) were recorded |

*Data to be filled in after mission when required per test.

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## TEST INFORMATION SHEET (RADAR DATA)

### MISSION PARTICULARS

Mission No. __6__
Date __1/31/73__
Weather __Overcast__
Site __Eglin Ridge__
WPN __105 mm Howitzer__
WPN Location (if known)
Az(Mils) __Unk__
RNG(KM)
Site Altitude(M) __391__

### GUN DATA

Charge __Unk__
Q.E.(Mils) __Unk__
Az (Mils)

RADAR MODE
Z (us) __26__
STC(on/off) __On__
N.O.B. (Deg) __+3 db__
PPI Scale (NM) __9__
Range(M)

### TEST DESCRIPTION  To determine ability to CUE by identifying

quickly approximate azimuth of unknown gun fire.

### RADAR STATUS  Hi Swept, CFA

### MISSION REMARKS  Wpn location - given after test - was at

edge of high clutter area - made accurate rance loc. difficult.

FP location was 380 located in SAA off Bald Ridge Rd.  Were told

before test FP would be BCA area.

### MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | B SCOPE DATA RNG | AZ | SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 1 | SCN | | | | | 6 x 20 | WPN | B-scope set to 2 nm, 210°. Did not see 1st round on PPI. |
| 2-5 | SCN | | | 6.5 2. | 211° 196° | | WPN TGT | Set B-scope for 191° 2 nm. Looked for fire on PPI. Saw rounds 2, 3, & 5 with 60% B/S. |
| | | | | | | | | Reported Az & range from PPI NOTE: Act. FP=380 (Rng = 10.45km at 3780 m.1 = 5.64 nm at 210° Az error for cue test = 1° located on 2 nd round. |

*Data to be filled in after mission when required per test.

73-0640-VB-44

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TEST INFORMATION SHEET (RADAR DATA)

## MISSION PARTICULARS

Mission No. __9__

Date __1/31/73__

Weather __Overcast-lightwind__

Site __Eglin Ridge__

*WPN __105 mm Howitzer__

*WPN Location (if known)
Az(Mils) __Unk__
RNG(KM)

Site Altitude(M) __391__

## *GUN DATA

Charge __Unk__
Q,E (Mils) __Unk__
AZ (Mils)

RADAR MODE
Z (us) __26__
STC(on/off) __On__
N.O.B. (Deg) __+3db__
PPI Scale (NM) __10 NM__
Range(M)

## TEST DESCRIPTION

To locate 105 mm Howitzer, fire from
6 unk pts firing to 6 unk impacts. 15 rounds to each
impact pt.

RADAR STATUS __Hi Swept, CFA__

MISSION REMARKS    Test plan called for fire from BCA to NAA/
SAA.   This was changed prior to test to fire from BCA,
NAA, SAA.  FP for series 1, 2, 3, & 4 in or near high
clutter area.

See Computer Sheets for refined data.

## MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | RNG | B SCOPE DATA AZ | SCALE | WPN/TGT FIND | REMARKS |
|---------|-------------------|--------------|----|-----|-----------------|-------|--------------|---------|
| Series 1-15 | | | | 6.1 nm<br>3 nm | 212°<br>203° | 6 x 20<br>" | WPN<br>TGT | Noted that two other weapons firing from same area as dedicated wpn.  difficult to pick right one.<br>Other wpn firing from 2H°, 5.75 NM – 1 MP at 207, 2.75 NM<br>2nd wpn firing from 219°, 7.35 NM – 1 mp at 207°, 2.75 NM<br>B-Scope data ia data on what was considered dedicated wpn.<br>B/S    70% |

*Data to be filled in after mission when required per test.

FP given after test was 347
11.53 KM at 3836 mils
Radar error = 850 meters

73-0640-VB-45

95

## MISSION PARTICULARS

Mission No. __9__
Date __1/31/73__
Weather __Overcast-light wind__
Site __Eglin Ridge__
*WPN __105 mm H.__
**WPN Location (if known)
Az(Mils) __Unk__
RNG(KM)
Site Altitude(M) __391 m.__

*GUN DATA
Charge __Unk__
Q,E,(Mils)
AZ (Mils) __Unk__
RADAR MODE
Z (us) __26__
STC(on/off) __On__
N.O.B. (Deg) __±1db__
PPI Scale (NM) __10__
Range(M)

TEST DESCRIPTION __To locate 105 mm Howitzer__

RADAR STATUS __High Swept CFA__

MISSION REMARKS __FP-given after test-was FP303 (Series 2)__
Again, other weapons were firing in general area. FP416
(Series 3) FP387 (Series 4), FP422 (Series 5), FP421
(Series 6) all given after test.

See Computer Sheets for refined data.

### MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | PPI DATA AZ | B SCOPE DATA RNG NM | B SCOPE DATA AZ Deg. | SCALE 20'/2 NM | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| Series 2 16-30 | SCN | | | 5.5 | 211.3° | 6 x 20 | WPN | B/S = 80% |
| | " | | | 2.95 | 199.3° | " | TGT | Fire from moderate clutter area saw all rounds |
| Series 3 31-45 | SCN | | | 4.5 | 199.0 | " | WPN | B/S = 80 to 90% – Looked at several rds in TP only but did not see |
| | " | | | 2.95 | 197.0 | " | TGT | fire from moderate clutter area. |
| Series 4 46-60* | SCN | | | 4.85 | 208° | " | WPN | B/S = 70% fire from high clutter |
| | " | | | 2.9 | 197° | " | TGT | area – behind Dodge Hill saw all rds. |
| Series 5 61-75 | SCN | | | 4.4 | 193° | " | WPN | B/S = 80% fire from low clutter |
| | " | | | 2.9 | 197.0 | " | TGT | area – saw all rds. |
| Series 6 | SCN | | | 3.95 | 184.6 | " | WPN | B/S = 100% fire from low clutter area saw all rds. |

*Data to be filled in after mission when required per test.

*NOTE: 1st reported dated FP4.7, 208° was error in transcribing. Correct measured radar data shown above.

| | Error Radar Data | FP |
|---|---|---|
| Series 2 | 710 M | 303 |
| 3 | 250 M | 416 |
| 4 | 760 M | 387 |
| 5 | 290 M | 422 |
| 6 | 200 M | 421 |

73-0640-VB-46

TEST INFORMATION SHEET (RADAR DATA)

## MISSION PARTICULARS

Mission No. __4__
Date __2/2/73__
Weather __Clear, Windy__
Site __Elgin Ridge__
*WPN __Unk__
*WPN Location (if known)
  Az(Mils) _____
  RNG(KM) _____
Site Altitude(M) __391__

## *GUN DATA

Charge __Unk__
Q.E.(Mils) __Unk__
AZ (Mils) _____
RADAR MODE
Z (us) __26__
STC(on/off) __see remarks__
N.O.B. (Deg) __+3 dB__
PPI Scale (NM) __9__
Range(M) _____

## TEST DESCRIPTION

To fire 8 rounds ea. from 4 weapons (4.2" mortar, 105 mm Howitzer, 155 mm Howitzer & 175 mm Gun) in Unk. sequence from unk FP to demonstrate ability to type classify weapon

RADAR STATUS __Hi swept, CFA__

## MISSION REMARKS

Weapon easily class identified after 1st round was fired. FP positively identified on PPI during 1st two rds. Weapon identified as 155 mm Howitzer.

## REMARKS

| RD | B/S | |
|----|-----|---|
| | | Excellent BSR on all rounds except Rd 6. |
| 1 | 3/4 | For Rd 6 had STC on |
| 2 | 4/4 | (20 db atten at 7 NM). |
| 3 | 3/4 | For all other rds STC |
| 4 | 2/4 | was off. |
| 5 | 5/5 | Est. of vel from B scope |
| 6 | | = .6 NM/scan≠243 m/s |
| 7 | 4/5 | ground vel. |
| 8 | 4/5 | |

Weapon classed as Howitzer based on velocity. After series 3 above weapon classed further as 155 mm Howitzer based on vel. rel. to 105 mm observed in series 3.

## MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | PPI DATA AZ | B SCOPE DATA RNG NM | B SCOPE DATA AZ | SCALE 2NM | 185° | WPN/TGT FIND |
|---------|-------------------|--------------|-------------|---------------------|-----------------|-----------|------|--------------|
| Series 1-8 | SCN | | | 7.4 | 195° | 6x20° | | WPN |
| | " | | | 5.65 | 198° | " | | TGT |

*Data to be filled in after mission when required per test.

73-0640-VB-47

TEST INFORMATION SHEET (RADAR DATA)

## MISSION PARTICULARS

Mission No. __4__
Date __2/2/73__
Weather __Clear, Windy__
Site __Elgin Ridge__
*WPN __UNK__
**WPN Location (if known)
Az(Mils) ____
RNG(KM) ____
Site Altitude(M) ____

*GUN DATA
Charge __UNK__
Q.E.(Mils) ____
AZ(Mils) ____
RADAR MODE __26__
Z (us) ____
STC(on/off) __see remarks__
N.O.B. (Deg) __+3 db__
PPI Scale (NM) __9__
Range(M) ____

TEST DESCRIPTION See sheet 1, Mission 4

RADAR STATUS __Hi swept, CFA   STC set (series 2) for ≤ 6 db__ at 6.5 NM

MISSION REMARKS __Radar signature & vel. made weapon easy__ to ID as mortar. STC was set too high for 1st 3rds on this low x-section tgt.

## MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | PPI DATA AZ | B SCOPE DATA RNG NM | AZ | SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| Series 1-8 | SCN | | | 7.35 | 195.5° | 2NM 185° 6x20° | WPN | |
| | " | | | 6.2 | 200° | | | |

REMARKS

| Rd | BSR | STC | |
|---|---|---|---|
| 1 | -- | on/off | Excellent BSR without STC. |
| 2 | -- | on | Poor with STC. |
| 3 | --- | on | Tgt. obviously low crosssection. |
| 4 | 5/5 | off | weapon was clas- |
| 5 | 4/5 | off | sified as mortar |
| 6 | 4/5 | off | on 1st observed |
| 7 | 1/5 | on | round based on |
| 8 | 4/6 | on | vel. & time of flt. |

Ground vel. computed to be 130 m/s based on spacing of hits on B-scope.

73-0640-VB-48

*Data to be filled in after mission when required per test.

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# TEST INFORMATION SHEET (RADAR DATA)

## MISSION PARTICULARS

Mission No. 4
Date 2/2/73
Weather Clear-Windy
Site Eglin Ridge
*WPN Unk
**WPN Location (if known)
Az(Mils) Unk
RNG(KM)
Site Altitude(M) 39/m

## TEST DESCRIPTION    See sheet 2, Mission 4

*GUN DATA
Charge Unk
Q.E.(Mils)
AZ(Mils)

RADAR MODE
Z (us) 26
STC(on/off) See remarks
N.O.B. (Deg) +3db
PPI Scale (NM) 9
Range(M)

RADAR STATUS  Hi swept, CFA – STC set to    10 db at 7 NM

MISSION REMARKS  Had 3 transmitter interlock interrupts at beginning of mission & missed 1st 3 rds.  Had used min. warm up time.

## MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | PPI DATA AZ | B SCOPE DATA RNG | B SCOPE DATA AZ | SCALE 2 NM 185° | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| Series 3 1-8 | SCN | | | 7.4 | 195° | 6 x 20" | WPN | |
| | " | | | 6.5 | 195° | " | TGT | |

Rd B.S.R. STC Excellent B.S.R. with
4  3/4  On  STC. Obviously larger
5  2/2  On  tgt than 4.2" mortar
6  2/2  On  which was impacting
7  3/3  On  at  same range.
8  3/3  On

Weapon was easily classed as
Howitzer on first, observed round.
Was further Id'ed as 105 mm
Howitzer based on lower vel. & cross
section relative to 155 mm Howitzer.

*Data to be filled in after mission when required per test.

73-0640-VB-49

## TEST INFORMATION SHEET (RADAR DATA)

### MISSION PARTICULARS

Mission No. __4__

Date __2/2/73__

Weather __Clear-Windy__

Site __Eglin Ridge__

*WPN __Unk__

**WPN Location (if known)
Az(Mils) __Unk__
RNG(KM) ____

Site Altitude(M) __391__

### *GUN DATA

Charge __Unk__
Q.E.(Mils) ____
AZ (Mils) ____

### RADAR MODE

Z (us) __26__
STC(on/off) __On__
N.O.B. (Deg) __+3 db__
PPI Scale (NM) __9 NM__
Range(M) ____

### TEST DESCRIPTION    See Sheet 1, Mission 4

RADAR STATUS __Hi swept, CFA, STC on__

MISSION REMARKS __Weapon easily classed as gun on first__
round.  STC set for   10 db at 6 NM.

### MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | B SCOPE DATA RNG NM | AZ Deg. | SCALE | WPN/TGT FIND | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| Series 4 1-8 | SCN | | | 7.4 | 194 | 6 x 20° | WPN | Rd | B.S.R. |
| | | | | 2.95 | 196 | " | TGT | 1 | 6/6 |
| | | | | | | | | 2 | 5/7 |
| | | | | | | | | 3 | Not recorded |
| | | | | | | | | 4 | 6/7 |
| | | | | | | | | 5 | 7/7 |
| | | | | | | | | 6 | 5/6 |
| | | | | | | | | 7 | 6/6 |
| | | | | | | | | 8 | Not recorded |

REMARKS: Excellent B.S.R. on all rds. Id'ed weapon as 175 mm gun·based on vel. Approximate vel. measured·on B-scope = 1 mi./4 sec. Rd. 3 was not recorded while vel. of weapon was being determined. Rd. 8 was not recorded due to taking pictures.

73-0640-VB-50

*Data to be filled in after mission when required per test.

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# TEST INFORMATION SHEET (RADAR DATA)

MISSION PARTICULARS

Mission No. __10__
Date __2/6/73__
Weather __Slight overcast&wind__
Site __FP181 West Range__
WPN __105 mm Howitzer__
WPN Location (if known) __FP 116__
Az(Mils) ____
RNG(KM) ____
Site Altitude(M) __1310 ft.__

*GUN DATA
Charge __4__ TOF __≈24 sec__
Q.E,(Mils) ____
AZ (Mils) ____
RADAR MODE
Z (us) __26 us__
STC(on/off) __off__
N.O.B. (Deg) __+3 db__
PPI Scale (NM) __10__
Range(M) ____

TEST DESCRIPTION __To confirm 105 mm Howitzer location with masking. Wpn & tgt location known__

RADAR STATUS __Hi swept, CFA__

MISSION REMARKS __Clutter in area of weapon was cancelled. Had excellent B.S.R. on all tracks. See computer sheets for final reduction__

MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | PPI DATA AZ | B SCOPE DATA RNG | AZ | SCALE NM 4.5° | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| Series 1-25 | SCN | | | 5.3 nm | 66.5° | 6x20° | WPN | B/S ratio on all 25 rounds was 95%. Typically 5 hits/round were observed. WPN at FP116. Error in wpn location from radar data (5.3 nm at 66.5° = 9.82 km at 1180 mil) was 200 meters. Tgt at Impact Pt. 140. Error in target location from radar data (2.7 nm, 60.5° = 5 Km at 1074 mil) was < 50 meters |
| | SCN | | | 2.7 nm | 60.5° | 6x20° | TGT | |

*Data to be filled in after mission when required per test.

73-0640-VB-51

## TEST INFORMATION SHEET (RADAR DATA)

### MISSION PARTICULARS

Mission No. 10
Date 2/6/73
Weather Slight overcast
Site FP 181
*WPN 105 mm Howitzer
**WPN Location (if known) FP116
   Az(Mils) _____
   RNG(KM) _____
Site Altitude(M) 1310 ft

**TEST DESCRIPTION** To confirm 105 mm Howitzer location with masking.

**RADAR STATUS** Hi swept, CFA

**MISSION REMARKS** Weapon was firing over signal Mt. large clutter area.

See computer sheets for final reduction

### *GUN DATA

Charge 4
Q.E.(Mils) _____
AZ(Mils) _____

### RADAR MODE

Z (us) 26
STC(on/off) off
N.O.B.(Deg) +3db
PPI Scale (NM) 10
Range(M) _____

### MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | PPI DATA AZ | B SCOPE DATA RNG NM | B SCOPE DATA AZ | SCALE 2KM 500 | WPN/TGT FIND | REMARKS |
|---------|-------------------|--------------|-------------|---------------------|-----------------|---------------|-------------|---------|
| Series 2 1-25 | SCN | | | 5.2 | 67.3° | 6x20 | WPN | Excellent B.S.R. on all tracks. Some hits near impact portion of track over signal Mt. missed. Avg B/S per track was 3 to 4 hits out of 5 to 6 possible. 1st 2/3 of track ≈ 100%. WPN at FP116. Error in wpn location from radar data (5.2 nm, 67.3° = 9.62 Km & 1196 mils) was 270 meters |

*Data to be filled in after mission when required per test.

73-0640-VB-52

## TEST INFORMATION SHEET (RADAR DATA)

**MISSION PARTICULARS**

Mission No. __11__
Date __2/7/73__
Weather __Rain & Windy__
Site __FP181 West Range__
*WPN __105 mm Howitzer (M102)__
*WPN Location (if known)
Az(Mils) __UNK__
RNG(KM) __UNK__
Site Altitude(M) __1310 ft.__

**TEST DESCRIPTION** __To locate 105 mm Howitzer from unknown__
__FP to unknown impact with masking.__

**RADAR STATUS** __Hi-swept, CFA-No problems__
__Started test on time.__

**MISSION REMARKS** __Good clutter cancellation, weather__
__condition. Rain with high wind gust (50 knots).__
__Computer data obtained on first five rounds. B/S on__
__remaining 20.__

*GUN DATA

Charge __UNK__
Q.E.(Mils) __UNK__
AZ (Mils) __UNK__

RADAR MODE
Z (us) __26 us__
STC(on/off) __off__
N.O.B. (Deg) __+3db__
PPI Scale (NM) __10__
Range(M) _____

**MISSION DATA**

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | B SCOPE DATA RNG | AZ | SCALE 2x58.5 | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| Series 1-25 | SCN | | | 5 nmi | 77.5° | 6x20 | WPN | B/S ratio on all 25 rounds was 95%. Typically 5 hits per round were observed. Radar error on 1st 5 rounds 100 meters. Impact in area of signal ant. 1st round observed on PPI 560 m error was noted after test was complete. |
| | | | | 3.1 nmi | 61.5° | 6x20 | TGT | |

*Data to be filled in after mission when required per test.

73-0640-VB-53

103

# TEST INFORMATION SHEET (RADAR DATA)

## MISSION PARTICULARS

Mission No. 11
Date 2/7/73
Weather Rain and Windy
Site FP181 West Range
*WPN 105 mm Howitzer (m102)
**WPN Location (if known)
  Az(Mils) UNK
  RNG(KM)
Site Altitude(M) 1310 Ft.

*GUN DATA
Charge UNK
Q.E.(Mils) UNK
AZ(Mils) UNK
RADAR MODE
Z (us) 26 us
BTC(on/off) off
N.O.B. (Deg) 3 db
PPI Scale (NM) 10
Range(M)

TEST DESCRIPTION To locate 105 mm Howitzer from UNK FP to UNK impact with masking.

RADAR STATUS Hi-swept CFA - no problems. Started test on time.

MISSION REMARKS Good clutter cancellation. Weather-rain with wind gusts (50 knots). Computer data obtained from first 5 rounds B/S ratio on the remaining 20 round.

## MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | PPI DATA AZ | RNG | B SCOPE DATA AZ | SCALE | WPN/TGT FIND | REMARKS |
|---------|-------------------|--------------|-------------|-----|-----------------|-------|--------------|---------|
| Series 1-25 | SCN | | | 5 nmi | 76.5° | 6x20 | WPN | B/S ratio on all 25 rounds was 70% typically 3 hits per round were observed. Radar error on 1st 5 rounds 150 meters. Impact area. Signal ant. More masking was observed on series 2 than series 1 in the impact area. |
| | SCN | | | 3.5 nm | 63.5° | 6x20 | TGT | |

*Data to be filled in after mission when required per test.

73-0640-VB-54

104

## TEST INFORMATION SHEET (RADAR DATA)

### MISSION PARTICULARS

Mission No. __12__
Date __2/8/73__
Weather __Clear/Cold/Windy__
Site __FP181 West Range__
WPN __105 mm Howitzer__
WPN Location (if known)
Az(Mils) __Unk__
RNG(KM) __Unk__
Site Altitude(M) __1310 ft.__

### *GUN DATA

Charge __Unk__
Q.E.(Mils) __Unk__
AZ (Mils) __Unk__

### RADAR MODE

Z (us) __26 us__
STC(on/off) __off__
N.O.B. (Deg) __3 db__
PPI Scale (NM) __10__
Range(M)

### TEST DESCRIPTION    To locate 105 mm Howitzer from

unk FP to unk impact (masking)

### RADAR STATUS   Hi-swept-CFA.   No problems.   Started test

on time.

### MISSION REMARKS   Weather- cold, windy (45 K gust)

Good cancellation

### MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | B SCOPE DATA RNG | AZ | SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| 1-15 Series 1 | SCN | 1st round 5nm | 55.5° | 5.75 nmi 3.8 nmi | 58° 52.5° | 25.5 6x20 6x20 | WPN TGT | B/S ratio on all 15 rounds 95% - typically 4 hits per round Radar error was 290 m impact area signal ant. first round error 1080 m. |

*Data to be filled in after mission when required per test.

73-0640-V8-55

105

# TEST INFORMATION SHEET (RADAR DATA)

## MISSION PARTICULARS

Mission No. 12
Date 2/8/73
Weather Clear,Windy,Cold
Site FP181 West Range
WPN 105 mm Howitzer
WPN Location (if known)
Az(Mils) Unk
RNG(KM) Unk
Site Altitude(M) 1310 ft

## GUN DATA

Charge Unk
Q.E.(Mils) Unk
AZ (Mils) Unk

### RADAR MODE

Z (us) 26 us
STC(on/off) off
N.O.B. (Deg) 3 db
PPI Scale (NM) 10
Range(M)

## TEST DESCRIPTION    To locate 105 mm Howitzer from unk

FP to unk impact

RADAR STATUS    Hi-swept – CFA    No problems

Started test on time.

MISSION REMARKS    Weather windy 45 Kt.gust,cold,good

cancellation

## MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | B SCOPE DATA RNG | AZ | SCALE 2X50.5 | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| Series 2 1-15 (rounds) | SCN | 4.8nmi (1st round) | 63° | 5.15 nmi | 63.5° | 6x20 | WPN | B/S on all 15 rounds |
| | | | | 4.1 nmi | 56.5° | 6x20 | TGT | 65% typically 3 hits observed per round. Radar error 220 meters Impact area signal ant. first round error 350 m |

*Data to be filled in after mission when required per test.

73-0640-VB-56

106

## TEST INFORMATION SHEET (RADAR DATA)

### MISSION PARTICULARS

Mission No. 12
Date 2/8/73
Weather Clear-Cold-Windy
Site FP 181 West Range
*WPN 105 Howitzer
**WPN Location (if known)
Az(Mils) Unk
RNG(KM) Unk
Site Altitude(M) 1310 ft.

### *GUN DATA

Charge Unk
Q,E,(Mils) Unk
AZ(Mils) Unt

RADAR MODE
Z (us) 26 us
STC(on/off) off
N.O.B. (Deg) 3 db
PPI Scale (NM) 10
Range(M)

### TEST DESCRIPTION To locate 105 mm Howitzer from Unk

FP to Unk impact

RADAR STATUS Hi-swept- CFA - No problems

Started test on time.
MISSION REMARKS Weather cold (-20° chill factor)

Windy 45 knot gusts, good cancellation

### MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | PPI DATA AZ | B SCOPE DATA RNG | B SCOPE DATA AZ | SCALE | WPN/TGT FIND | REMARKS |
|---------|-------------------|--------------|-------------|------------------|------------------|-------|--------------|---------|
| Series 3 | SCN | | | 4.75 nmi | 72.7° | 6x20 | WPN | B/S ratio on all 15 rounds 20%. Typically 3 hits were observed per round. |
| | SCN | | | 3.8 nmi | 63.2° | 6x20 | TGT | Radar error 220 m impact area signal ant. 1st round error not obtained because of low B-S. |
| 1-15 (Rounds) | | | | | | | | |

*Data to be filled in after mission when required per test.

73-0640-VB-57

107

# TEST INFORMATION SHEET (RADAR DATA)

## MISSION PARTICULARS

Mission No. __15A__
Date __2/21/73__
Weather __Windy, Cold__
Site __PQA-2__
*WPN __8" Howitzer__
*WPN Location (if known)
Az(Mils) __FP24__
RNG(KM)
Site Altitude(M) __1370 ft.__

*GUN DATA Seq __2__
Charge __7__ __6__
Q.E.(Mils) __546618__
AZ (Mils) __4900__
RADAR MODE
Z (us) __26__
STC(on/off) __off__
N.O.B. (Deg) __3db__
PPI Scale (NM) __10__
Range(M)

## TEST DESCRIPTION

To confirm 8" Howitzer location with masking. Both WPN and tgt location are known.

**RADAR STATUS** Hi-swept, CFA power - no radar failures.

**MISSION REMARKS** Strong winds prevailed during test. Large point clutter (QRCT) was present along the trajectory of the rounds.

## MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | PPI DATA AZ | B SCOPE DATA RNG n.m | B SCOPE DATA AZ | B SCOPE DATA SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| Seq.1 10 rounds | SCN | | | 9.1 | 83.5° | 6x20° | WPN | B/S ratio for seq. 1 was 35% |
| | SCN | | | 1.5 | 33.0° | 6x20° | TGT | Typically 4 hits/round were observed. The radar error for Seq. 1 was 225 meters. |
| Seq. 2 15 rounds | SCN | | | 9.1 | 83.5° | 6x20° | WPN | B/S ratio for Seq. 2 was 25% |
| | SCN | | | 2.5 | 45° | 6x20° | TGT | Typically 3 hits/round were observed. The radar error for seq. 2 was 225 meters. See computer sheets for additional info. |

The large point clutter which captured the target for several scan would account for some of the low B/S ratios.

*Data to be filled in after mission when required per test.

73-0640-VB-58

## TEST INFORMATION SHEET (RADAR DATA)

### MISSION PARTICULARS

Mission No. 16A Seq. 1
Date __2/22/73__
Weather __Cold, Snow__
Site __POA2__
*WPN __8" Howitzer__
*WPN Location (if known)
Az(Mils) __Unk__
RNG(KM) _____
Site Altitude(M) __1370 ft.__

### *GUN DATA

Charge __Unk.__
Q,E,(Mils) __Unk__
AZ (Mils) __Unk__

### RADAR MODE

Z (us) __26 us__
STC(on/off) __off__
N.O.B. (Deg) __3 db__
PPI Scale (NM) __10 nmi__
Range(M)

### TEST DESCRIPTION __to locate an 8" Howitzer firing__

__from an unknown F.P. to an unknown tgt.__

RADAR STATUS __Hi-swept, CFA__

__No failures__

MISSION REMARKS __Very heavy snow-during test-visibility__
__1000 meters.  Large point clutter in path of the__
__rounds.__

### MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | B SCOPE DATA RNG | AZ | SCALE | WPN/TGT FIND | REMARKS |
|---------|-------|------|----|------|------|-------|---------|---------|
| Seq. 1 | SCN | | | 9.8 | 85.0° | 6x20° | WPN | The B/S ratio for this seq. was 20%.  Typically 2 hits per round.  The point clutter in the path of the round accounted for some loss of hits. |
| 20 Rounds | SCN | | | 2.1 | 29.5° | 6x20° | TGT | Good detection was noted at the wpn. |
| | | | | | | | | The radar error for Seq. 1 was 75 meters. |
| | | | | | | | | See computer sheets for further WPN information. |

*Data to be filled in after mission when required per test.

73-0640-V8-59

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## TEST INFORMATION SHEET (RADAR DATA)

**MISSION PARTICULARS**

Mission No. __16A Seq. 2__
Date __2/22/73__
Weather __Cold, snow__
Site __POA-2__
WPN __8" Howitzer__
WPN Location (if known)
  Az(Mils) __Unk.__
  RNG(KM) __Unk.__
Site Altitude(M) __1370 ft.__

*GUN DATA
Charge __Unk__
Q.E.(Mils) _____
AZ (Mils) _____

RADAR MODE
Z (us) __26 us__
STC(on/off) __off__
N.O.B. (Deg) __3 db__
PPI Scale (NM) __10__
Range(M) _____

**TEST DESCRIPTION** __To locate an 8" Howitzer firing from__
__an unknown F.P. to an unknown target.__

RADAR STATUS __Hi swept CFA   No failures.__

MISSION REMARKS __Very heavy snow during the test.__
__Visibility 1000 meters, large point clutter in path__
__of the rounds.__

### MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | PPI DATA AZ | B SCOPE DATA RNG n.mi | B SCOPE DATA AZ | B SCOPE DATA SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| Seq. 2 | SCN | | | 8.8 | 84.5° | 6x20° | WPN | The B/S ratio for this seq. was 50%. Typically 6 hits/round. Point clutter would account for some B/S loss. |
| | SCN | | | 2.2 | 30.0° | 6x20° | TGT. | Good detection was noted at WPN. The radar error for seq. 2 was 80 meters. See computer sheets for further WPN info. |

*Data to be filled in after mission when required per test.

73-0640-VB-60

110

TEST INFORMATION SHEET (RADAR DATA)

MISSION PARTICULARS

Mission No. 13
Date 2/27/71
Weather Clear, Warm
Site POA2
*WPN 155 Battery
*WPN Location (if known)
Az(Mils) FP 710
RNG(KM)
Site Altitude(M) 1350 ft.

TEST DESCRIPTION  To confirm the location of a 155
battery (Battery 4 with 3 transfers)

*GUN DATA

Charge 6
Q,E,(Mils) 416,458,420
AZ (Mils)

RADAR MODE
Z (us) 26
STC(on/off) off
N.O.B. (Deg) 3 db
PPI Scale (NM) 10
Range(M)

RADAR STATUS  No failures - rotary joint damaged when
the truck hit an overhang.

MISSION REMARKS   Transfer #1 was run with 0 db in the
rec. front end, transfer #2 with 12 db atten.  (X2 in
range) Transfer #3 with 6 db atten (X 1.4 in range)

MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | PPI DATA AZ | B SCOPE DATA RNG | B SCOPE DATA AZ | SCALE | WPN/TGT FIND | REMARKS |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Transfer #1 | SCN | | | 6.6 nmi. | 75.1° | 6x20° | WPN | Good blip scan (70%) was obtained for transfer #1.  5 hits out of 7 possible.  Radar location error 280 meters. |
| | SCN | | | 2.2 nmi | 48.7° | 6x20° | Tgt. | |
| Transfer #2 | SCN | | | 6.6 nmi. | 74.1° | 6x20° | WPN | With 12 db atten. the affect. range of the WPN was 13.2 nmi (24.4 Km). Blip scan good for location and cueing radar location error 360 meters |
| | SCN | | | 2.0 nmi. | 26.7° | 6x20° | Tgt. | |
| Transfer #3 | SCN | | | 6.7 nmi. | 75.6° | 6x20° | WPN | With 6 db atten. the affect. range of the WPN was 9.3 nmi (17.2 Km) Blip scan 70% 5 hits out of 7 possible. Radar location error 80 meters. |
| | SCN | | | 2.1 nmi. | 49.3° | 6x20° | Tgt. | |

*Data to be filled in after mission when required per test.

73-0640-VB-61

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TEST INFORMATION SHEET (RADAR DATA)

Special Test

MISSION PARTICULARS

Registration of

Mission No. 155 Battery

Date 2/27/73

Weather Clear, Warm

Site POA2

*WFN

**WFN Location (if known)

Az(Mils) _____

RNG(KM) _____

Site Altitude(M) 1350 ft.

TEST DESCRIPTION Not part of normal test -

locating a 155 battery during the registration rounds.

RADAR STATUS No failures - rotary joint damaged when

truck hit an overhang

MISSION REMARKS _____

*GUN DATA

Charge Unk

Q,E (Mils)

AZ (Mils)

RADAR MODE

Z (us) 26 us

STC(on/off) off

N.O.B. (Deg) 3 db

PPI Scale (NM) 10

Range(M)

MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | B SCOPE DATA RNG | AZ | SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| Battery | SCN | | | 6.75 nmi | 75.6° | 6x20° | WPN | Good blip scan ratio 70% |
| Registra-tion Rounds (5) | SCN | | | 2.15 nmi | 49.5° | 6x20° | Tgt | (5 hits out of a possible 7) radar locating error 80 meters |

*Data to be filled in after mission when required per test.

73-0640-VB-62

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## TEST INFORMATION SHEET (RADAR DATA)

**MISSION PARTICULARS**

Mission No. __13A__
Date __2/28/73__
Weather __Windy.Cold.Cloudy__
Site __POA2__
*WPN __705__
**WPN Location (if known)
  Az(Mils) _____
  RNG(KM) _____
Site Altitude(ﬆ) __1350 ft.__

**TEST DESCRIPTION** To locate a 155 battery firing from an
__unknown fire point to an unknown target.__
__(Battery 4 with 3 transfers)__
**RADAR STATUS** __Rotary joint damaged when truck hit an__
__overhang (No radar failures)__
**MISSION REMARKS**

*GUN DATA
Charge __6__
Q.E.(Mils) __305.349__ 331
AZ (Mils)
RADAR MODE
Z (us) __26__
STC(on/off) __off__
N.O.B. (Deg) __3db__
PPI Scale (NM) __10__
Range(M)

**MISSION DATA**

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | PPI DATA AZ | B SCOPE DATA RNG | B SCOPE DATA AZ | SCALE | WPN/TGT FIND | REMARKS |
|---------|-------------------|--------------|-------------|------------------|-----------------|-------|--------------|---------|
| Transfer #1 | SCN | | | 6.15 nmi | 84.5° | 6x20° | WPN | Blip scan ratio 80% |
| | SCN | | | 2.5 nmi | 60° | 6x20° | Tgt | Typically 5 hit out of a possible 6. Radar error 280 meters. |
| Transfer #2 | SCN | | | 6.15 nmi | 85° | 6x20° | WPN | Blip scan ratio 80% |
| | SCN | | | 2.0 nmi | 52° | 6x20° | Tgt | Radar error 300 meters |
| Transfer #3 | SCN | | | 6.15 nmi | 84.5° | 6x20° | WPN | Blip scan ratio 80% |
| | SCN | | | 2.0 nmi | 53° | 6x20° | Tgt | Radar error 280 meters |

*Data to be filled in after mission when required per test.

Note: In all cases the WPN was firing
approx. 600 meters from a large point
clutter QRCT.

73-0640-VB-63

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## TEST INFORMATION SHEET (RADAR DATA)

### MISSION PARTICULARS

Mission No. __18__
Date __3/6/73__
Weather __Clear, Warm__
Site __Gate House__
*WPN __42" mortar__
**WPN Location (if known)
Az(Mils) __FP 90__
RNG(KM) _____
Site Altitude(M) __1212 ft__

*GUN DATA __Seq.__ Seq. 1 | 2

| Charge | 1 | 2 |
| Q.E.(Mils) | 19 4/8 | 19 2/8 |
| AZ (Mils) | 900 | |

RADAR MODE
Z (us) __26-4__
STC(on/off) __off__
N.O.B. (Deg) __3 db__
PPI Scale (NM) __10__
Range(M) _____

TEST DESCRIPTION __To confirm 4.2" mortar location.__
__Also to compare the results with the 81 mm mortar__
__fired from the same F.P.__

RADAR STATUS __Hi-swept PRF (Failure) the radar was still__
__able to perform the mission.__

MISSION REMARKS __Seq. 1 - 10 rounds - 26 us mode.__
__Seq. 2 - 10 rounds 4 us mode.__
__High point clutter in area of WPN and TGT__

### MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | B SCOPE DATA RNG | AZ | SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| Seq. 1 10 rounds | SCN | -- | -- | -- | -- | -- | -- | Seq. 1 was run in the 26 us radar mode. The high point clutter in the area of the WPN and TGT made it impossible to see the rounds. |
| Seq. 2 10 rounds | SCN | | | 3.0 nmi | 337° | 6x20° | WPN | Seq. 2 was run in the 4 us mode The blip scan was 42%. Radar locating error 180 meters. The high point clutter in the area of the target and WPN caused some hits to be lost. |
| | | | | 4.0 nmi | 314° | 6x20° | TGT | The 4.2" appeared to be a little smaller target than the 81 mm. |

*Data to be filled in after mission when required per test.

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## TEST INFORMATION SHEET (RADAR DATA)

### MISSION PARTICULARS

Mission No. __18__

Date __3/6/73__

Weather __Clear, Warm__

Site __Gate House__

*WPN __81 mm mortar__

**WPN Location (if known)
Az(Mils) __FP 90__
RNG(KM) _____

Site Altitude(**) __1212 ft.__

---

*GUN DATA  Seq. __3__   Seq. __4__

Charge _____
Q.E.(Mils) __1004, 1020__
AZ (Mils) _____

RADAR MODE
Z (us) __26-4__
STC(on/off) __off__
N.O.B. (Deg) __3 db__
PPI Scale (NM) __10__
Range(M) _____

TEST DESCRIPTION   To confirm 81 mm mortar location also compare the results with the 4.2" mortar fired from the same F.P.

RADAR STATUS   Hi-swept PRF (failure) the radar was still able to perform the mission.

MISSION REMARKS   Seq. 3 - 10 rounds 26 us mode

Seq. 4 - 10 rounds 4 us mode

High point clutter in area of WPN and Tgt.

---

### MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | AZ | B SCOPE DATA RNG | AZ | SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| Seq. 3 10 rounds | SCN | | | | | | | Seq. 3 was run in the 26 us radar mode. The high point clutter in the area of the WPN and tgt. Made it impossible to see the rounds. |
| Seq. 4 | SCN | | | 2.9 nmi | 337.8° | 6x20° | WPN | Seq. 4 was run in the 4 us mode. The blip scan ratio was 57% Radar location error 75 meters. The high point clutter in the area of the WPN and TGT caused some loss of hits as was the case in the 4.2" mortar. As seen from the B/S ratio the 81 mm mortar appears to be somewhat larger target. |
| | | | | 3.5 nmi | 316° | 6x20° | Tgt | |

*Data to be filled in after mission when required per test.

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## TEST INFORMATION SHEET (RADAR DATA)

MISSION PARTICULARS

Mission No. __17__
Date __3/6/773__
Weather __Clear, Warm__
Site __Gate House__
WPN __175 mm__
WPN Location (if known)
  Az(Mils) __FP 30__
  RNG(KM)
Site Altitude(✗) __1212 ft.__

TEST DESCRIPTION __To confirm the location of the 175 mm__
  WPN - (16 round fired)

RADAR STATUS __H swept PRF (failure) the radar was still__
  __able to perform the mission.__

MISSION REMARKS

*GUN DATA
  Charge __2__
  Q.E,(Mils) __680__
  AZ (Mils)

RADAR MODE
  Z (us) __26 us__
  STC(on/off) __off__
  N.O.B. (Deg) __3 db__
  PPI Scale (NM) __15__
  Range(M)

MISSION DATA

| RND NO. | FIND MODE SCN/SCH | PPI DATA RNG | PPI DATA AZ | RNG | B SCOPE DATA AZ | B SCOPE DATA SCALE | WPN/TGT FIND | REMARKS |
|---|---|---|---|---|---|---|---|---|
| Seq. 1 16 rounds | ---- | -- | -- | --- | --- | --- | --- | The first half of the trajectory was not seen. The last half was seen on all 16 rounds. Blip scan ratio for the entire trajectory was 31%. Blip scan ratio for the last half was 62%. Some hits were lost because of point clutter (QRCT). The rounds were seen from 12 Km to impact at 24 Km. |

*Data to be filled in after mission when required per test.

73-0640-VB-66

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